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New Polychaetous Annelids From Laguna Beach, California

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In a very interesting collection of annelids from Laguna Beach transmitted to me for study by Prof. Hilton, the apparently previously undescribed forms listed below are represented. As a comprehensive report on the annelids of the region to follow further explorations and collecting is in contemplation, I am giving here only such preliminary accounts of the new forms as are thought sufficient for their identification in the local fauna. The types of all these species are in the Museum of Comparative Zoology at Cambridge.

POLYNOIDAE

Halosydna latior sp. nov.

A species proportionately broader over all than the usual forms of the common *H. insignis, californica,* and *pulchra.* It is characterized by elytra not only closely imbricated along each side but also broadly overlapping in the middle line throughout the length. The elytra in general are unusually elongate in an oblique direction, the long axis running from the outer end cephalomesad; the outline subelliptic, the caudomesal edge broadly convex, the opposite one a little incurved at middle. The entire surface of elytra subdensely covered with very small rounded brown nodules or tubercles; within the middle region, just behind the edge of the preceding overlapping elytron, a number of much larger paler tubercles which in the type are present on all excepting the last pair. Elytra extending to outer ends of parapodia. Eighteen pairs of elytra present. Prostomium subangularly bulging on each side, the anterior eye at the angle, the posterior eye removed far caudad, by about half the greatest width of the prostomium. Paired anterior prolongations of the prostomium very long, as long as the median length of the prostomium back to level of posterior eyes, distally clavate. Median ceratophore much stouter than the lateral prolongations and exceeding them by more than a third in length. Median tentacle long, nearly attaining end of palpi; slender, narrowing distad, only slightly thickened subapically, with the usual slender tip which is of moderate length. Lateral tentacles much shorter, their tips reaching only to near middle of light region between proximal black region and subapical black ring of median tentacle. Tentacular cirri resembling median tentacle in form, being narrowed distad with subapical enlargement slight; one or two fine setae emerging from a small nodule at distal end of parapodium proximad of tentacular cirrus. The notocirri in general have the same characteristic form as the tentacular cirri, narrowing continuously distad with the subapical enlargement slight. First neurocirrus very elongate, surpassing the parapodium. The other neurocirri slenderly cylindroconical, narrowed into a slender tip and a little narrowed proximally; attached well toward base of parapodium the end of which they fail much of attaining. A characteristic feature is the elongate form of the nephridial papillae, these in the type as preserved being mostly near three times as long as thick at the middle. Neuropodial setae dark amber colored, numerous, arranged in two continuous regions, a narrow dorsal one and a much broader ventral one in the latter of which the setae form four distinct longitudinal series with five or six setae in each series. Notopodials moderate in

number, the dorsal ones short, the most ventral long, attaining the end of the neuropodium. The elytra are greyish with dusky or brownish mottlings. Notocirri with dark annulations as usual.

Length, 42 mm.; width to end of setae, 14 mm.; to end of parapodia, 10.8 mm.; exclusive of parapodia, 7 mm.

Taken on Laguna Beach at Mussel Point (Hamilton coll.).

Type—M. C. Z. 2, 138.

Halosydna tuberculifer sp. nov.

Among other forms known from the California coast characterized especially by the strong tuberculation of all the elytra. The tubercles are mostly large and conical though some are rounded and are confined chiefly to the mesocaudal half and median region of each elytron, a series of large ones ordinarily present along the caudal and caudomesal margin; in the first two or three pairs of elytra the tubercles of the median region especially large, the tubercles on the first pair occurring on the anterior part as well; ectal margin of elytra strongly fringed or ciliate. Elytra in general subcircular but with margin of ectocephalic side flattened or in part a little incurved. Elytra in contact or nearly so at median line but not there at all overlapping. Pairs of elytra eighteen, these being present on somites II, IV, V, VII, IX and so on alternate ones to XXV and then on XXVI, XXVIII, XXX, XXXI, and XXXIII. The last three setigerous somites bear notocirri. Anterior pair of eyes near middle of length of prostomium proper, larger than posterior pair which are a little closer together and are well removed from the others. Lateral prolongations of the prostomium in front which bear the lateral tentacles only a little shorter than the median ceratophore though much more slender. Median tentacle shorter than the palpi, moderately enlarged and strongly rounded subapically and with the usual slender tip or filament which is comparatively short. The lateral tentacles of similar form but much shorter and more slender. Neurocirri of first normal segment large, resembling a notocirrus. The other neurocirri much shorter, subconical, constricted at base and prolonged into a slender but short tip; attached near base of neuropodium in each case. Anal cirri similar to notocirri but much longer and stouter. Neuropodial setae of usual general form, amber colored with dark tip, arranged mostly in two or three, usually uneven, subvertical series. The notopodial setae fine, numerous, the longer ones not falling much short of or reaching the ends of the neuropodials. The nephridial papillae occupy the ordinary position; they are small and unusually short. The color of the elytra uniform greyish brown. Antennae, tentacular cirri and notocirri banded at base and distally with black.

Length, 23 mm.; width exclusive of parapodia, 3 mm. A little narrowed cephalad, somewhat more so caudal.

Taken at Laguna Beach under stones. (1917)

Type—M. C. Z. 2, 139.

Halosydna leioseta sp. nov.

Body strongly and continuously narrowed caudad. Prostomium wider than long, deeply bilobed, the median tentacle inserted deeply in the intervening incision. Lobes extended forward into peaks which, however, are constricted at base so as to give appearance of more or less distinct ceratophores, these short. Anterior eye free on each side, the caudal one much farther mesad and overlapped by the peristomium. Tentacles short, the median line a little longest and about equalling the palpi; in

each a slender tip above the moderate subdistal swelling about equal in length to the remaining part of the style. Tentacular cirri similarly formed, as is also the first neurocirrus, the latter less clavate below the slender tip. Other neurocirri much shorter, shortly subfusiform with filiform tip short; characteristically inserted almost precisely at middle of length of the neuropodium. Notopodia reduced to small lobes at base of neuropodia above, these lobes smooth, bearing no emergent setae in the type. In the average neuropodium the setae are mostly six in number; these are coarse, with subhastate heads the tips of which are curved, entire, and acute; the surface appears smooth, the seriate spinules being exceedingly minute and easily overlooked; pale straw colored. The notocirri have the usual enlarged distal end baring a slender tip and a little exceed the neuropodial setae. The elytra have an arrangement in general similar to that normal in Halosydna so far as that usually goes, but twenty-four pairs are present, these occurring on somites, II, IV, V, VII, IX, XI, XIII, XV, XVII, XIX, XXI, XXIII, and XXVI, XXVIII, XXIX, XXXI, XXXIII, XXXV, XXXVII, XXXIX, XLI, XLIII, XLV, and XLVII. The elytra are characteristically widely imbricated so as completely to cover the dorsum and prostomium. They extend out far laterally so as wholly to overlap the parapodia proper though the ends of the setae and notocirri extend beyond the edges. The elytra have the surface wholly smooth and the edges are also not fringed. As preserved, the type has no definite color markings; color greyish, the elytra of weak fulvous cast.

Length near 22 mm.; greatest width exclusive of parapodia, 2.8 mm.; to ends of parapodia, 5 mm.; to ends of setae, 6.8 mm.

Taken as a commensal on a sea-urchin (Metz, July 20, 1911).

Type—M. C. Z. 2, 140.

Lepidonotus setosior sp. nov.

Readily distinguished from *L. squamatus, coeloris* and other species recorded from the Pacific coasts of North and South America by the greater length and coarseness of the notopodial setae, these being stout pointed spines often nearly attaining the ends of the neuropodials and thus exceeding the latter in actual length. The notopodials, however, are obviously more slender than the neuropodials; they are much more numerous than the neuropodials and form a dense, subcylindrical, spreading group. The elytra are characterized by bearing over their free portions numerous high and stout, conical, hard or chitinous tubercles which are, however, much less dense than the very different rounded eminences of *squamatus,* these cones often roughened; between these high cones, and over the covered part of the elytra as well, numerous small rounded tubercles or nodules; much more slender and shorter, erect, conical papillae present on the outer border of at least some of the elytra but no truly ciliate fringe could be detected in the types. The elytra are long, subelliptic in outline, and are arranged either with axis nearly longitudinal or very oblique, the most anterior elytra, however, subcircular. Eyes on each side unusually widely separated, the anterior one low on side, a little ectocaudad of base of anterior process. Anterior processes of prostomium about four-fifths as long as the median ceratophore and much more slender. Lateral tentacles much more slender than the median, and, exclusive of the filamentous tip, falling short of attaining the middle of the style of the latter exclusive of its tip; styles biannulate with black as frequent, the basal process also black. Median tentacle surpassing palpi in length; subapical swelling pronounced, much more so than that of the laterals. Tentacular cirri and notocirri similar in form to

the median tentacle. Anal cirri proportionately somewhat shorter than in *squamatus*. Color of venter and parapodia grey; elytra at present grey over a fulvous ground. Setae dark amber to nearly ferruginous, darker than usual in *squamatus*. A paratype has elytra fulvous of dilute ferruginous cast with black mottlings.

Length, 18 mm.

Type—M. C. Z. 2, 141.

Lepidonotus leius sp. nov.

A species characterized by its rather thin, easily detached elytra which have their surface wholly smooth or, at most, showing a few scattered minute points; closely fringed along the outer margin, about the cephaloectal region, and for a short distance along the anterior edge. Elytrophore attached cephaloectad of middle. Anterior and ectal margins of a typical elytron only weakly convex, the cephaloectal corner subrectangular though rounded; caudal margin strongly convex, the inner end of elytron like the end of an ellipse but with lower margin the more oblique. Elytra transverse or but little oblique, strongly overlapping in the middorsal line. Prostomium of usual general form. Eyes large and black, the anterior ones near middle of main region of prostomium, the posterior ones closer together and at caudal end. Only one tentacle, a lateral, retained in type. This characterized by a short cylindrical style which to the base of the distal swelling is scarcely longer than the basal process, and especially by an unusually long slender tip which is as long as the rest of the style. The parapodium of the first segment bears two prominent setae in the usual position; tentacular cirri of usual form, the filiform tips long, when bent back reaching proximad of middle of style. Notocirri also characterized by their long terminal filaments. Neuropodial setae light amber-colored; arranged in the usual vertically elongate patch, presenting a narrow dorsal half and a broader ventral one. In the ventral part of the patch normally four longitudinal rows of three setae each, while the narrower upper region shows also about four rows but with only two or one in each. The setae have the usual general structure. Notopodials numerous, reaching beyond distal end of neuropodia and sometimes nearly to middle of the neuropodial setae. In the type the elytra are light brown. The tentacles and notocirri ringed with black as common.

Length, 13 mm.; width exclusive of parapodia, 3 mm.; width to tips of setae, 6 mm.

Dredged.

Type—M. C. Z. 2, 142.

PHYLLODOCIDAE

Hesperophyllum gen. nov.

Similar in general to *Notophyllum* and *Austrophyllum* but differing especially in having the ventral cirrus of the second segment flattened and foliaceous and strongly asymmetrical. It is like *Notophyllum* and unlike *Austrophyllum* in having the first segment dorsally reduced.

Genotype.—H. tectum sp. nov.

Hesperophyllum tectum sp. nov.

The first segment dorsally reduced. Ventral tentacular cirrus of second somite of a thin or foliaceous and asymmetrical form. Other tentacular cirri subcylindric, reduced distally to a pointed tip, that of I about half as long as the dorsals of II

and III. Paired tentacles short, proximally thick and convexly bulging, abruptly narrowed to an acute tip with incurving sides. Unpaired tentacle situated between eyes in line connectnig their centers, nearly of same length and size as the first tentacular cirri and about as long also as prostomium; annulate. Prostomium shortly subcordate, well rounded in front, incurved caudally. With very large cirri of which the dorsals widely overlap in the middle and thus completely cover the dorsum, the prostomium normally also being wholly concealed from above. The neurocirrus of a typical parapodium is attached by a broad base extending from a pronounced ventral swelling or flange (neurocirrophore) across the caudal sid of the parapodium to its dorsal edge and projects farther dorsad of the parapodium than ventrad, the dorsomesal end widely rounded; much broader dorsoventrally than long, with the free edge evenly rounded. The notocirrophore in a thick rounded body arising from the base of the parapodium proper and showing the notopodium as a proportionately much smaller lobe on its ectal side; the style is attached about its caudal half-circumference and is broadly subreniform with the free margin coarsely crenulate or wavy, its mesal limb widely overlapping that of the opposite notocirrus and its ectal one overlapping the neurocirrus. Surface of cirri and of somites, especially ventrally, densely covered with very fine brown dots or points. Number of segments in type, near seventy-three. Body narrowing caudad, becoming narrow and pointed at posterior end. Proboscis unknown.

Length, 19 mm.

Type—M. C. Z. 2, 143.

Dredged. Brown in life, this color being also retained in the preserved type specimen. A paratype has a greenish cast. This species suggests *Notophyllum imbricatum* Moore in the large imbricated notocirri covering the dorsum but in the latter all the tentacular cirri are of the elongate, symmetrical, evenly tapering form charactceristic of its genus. *Imbricatum* similarly presents nuchal appendages, but these are three in number on each side and slender, instead of two broad, subelliptic lobes. The neuropodium is distally narrowed instead of broad, the head is differently formed, and various other differences are present throughout.

Steggoa gracilior sp. nov.

This is a small and slender form noted as green in life and also retaining this color after preservation in alcohol. It agrees in general with *Steggoa,* the first segment being normally developed above and distinct from the prostomium though not so clearly separated as usual, suggesting a tendency toward the *Hypoeulalia* condition. Prostomium a little longer than wide, narrowed anteriorly, sides convex; a short lobe, rounded in front and bearing the four tentacles, is set off by a weak constriction from the basal part. Unpaired tentacle situated well caudad, more slender than the paired ones but nearly as long. Eyes not detected. Ventral tentacular cirrus of II of a thick, leaf-shaped form, sublanceolate in outline and much like the notocirri. The other tentacular cirri longer and filiform. Notocirri in outline lanceolate, characteristically exceptionally thick in proportion to width so as at times to appear nearly subconical. Neurocirri much smaller; similarly proportionately thick and at times subconical. Body slender, strongly narrowed from the middle toward both ends. The

proboscis densely and uniformly papillose throughout. Number of segments near one hundred and twenty-three.

Length, about 26 mm.

Type—M. C. Z. 2, 144.

Sige californiensis sp. nov.

Corresponding closely in general characters with *S. macroceros* (Grube), the genotype. Green in color instead of straw-yellow to brown. Tentacles long and slender as in *macroceros*, with the median equalling the others in length and inserted close to the base of the latter; tips of tentacles slenderly attenuated. The eyes seem to be proportionately larger than in *macroceros*. The first segment is reduced above at the sides where the prostomium bulges back on each side; but the middle region is well developed, extending forward on the base of the head as a rounded lobe or flap. Very easily distinguished from *macroceros* and other known species by the form of the ventral tentacular cirrus of the second segment which, in place of the ordinarily lanceolate foliaceous form, is very strongly expanded above the base, presenting a large rounded lobe in front and an abruptly much more slender tip, with the blade as a whole irregularly twisted. The parapodia very similar to those of the genotype; but the setigerous lobe less acutely and less deeply notched and rather broader across the end along the setigerous line. The notocirri rather more slender and narrowed more evenly distally, not incurved on each side distally so as to leave an elongate tip set off from the rest. The neurocirri similar but more asymmetrical, the upper margin straight or concave, the lower convex. Anal cirri missing. Proboscis not protruded. Total number of segments in the type, which is complete, sixty-eight.

Length, 10 mm.

Type—M. C. Z. 2, 145.

Taken under stones.

Moore has described *Eulalia* (*Sige*) *bifoliata* from Monterey Bay; but as the ventral tentacular cirrus of II is described and figured as cylindroconical, that species cannot be properly referred to *Sige* as now restricted.

Anaitides heterocirrus sp. nov.

Close to *A. mucosa* (Oersted) in the characters of the proboscis, having similarly six rows of papillae proximally on each side with the number in each series normally nine or ten, but distinct in the form of the cirri. The three first pairs of normal foliaceous notocirri much smaller than the succeeding ones and different in shape, being very broadly and evenly elliptic, the distal end of the third, e. g., broadly rounded, not conspicuously narrowed as in *mucosa*. In the average parapodia of the middle region of the body the neurocirri are obviously broader with the tip stouter and less acute; and the notocirri, while in general somewhat similar in form, are more elongate with a more pronounced ventral lobe, the distoectal angle more acute and more produced, while the distomesal corner is more rounded, and the proportionate width across the distal end appears less. The prostomium very broadly cordate, notched or constricted at the sides near the anterior third which is distally broadly rounded; tentacles inserted on each side at or just distad of the constriction, conical and of moderate length; caudal margin conspicuously angularly incised at middle and there embracing a conspicuous nuchal papilla. Eyes about twice their diameter apart. The type is incomplete caudally, at present consisting of ninety-five somites and having a length

of 35 mm. with a maximum width, exclusive of parapodia, of 2 mm. The body at present has a purplish tinge.

Dredged at 10 fathoms on Aug. 27, 1917.

Type—M. C. Z. 2, 146.

SYLLIDAE

Typosyllis bella sp. nov.

Differing from *armillaris* (Müller), *alternata* (Moore) and related forms in the form and relations of the prostomium and its appendages. The prostomium is broadest anteriorly, narrowing caudad and rounded forward a little at middle in front. A characteristic feature is that the three tentacles are in a transverse line along the anterior edge, the median being thus inserted far in advance of the posterior eyes. A median longitudinal furrow extending forward from caudal edge to base of median tentacle. The anterior eyes much larger than the posterior and farther apart, each somewhat transversely elliptic and located far forward at base of lateral tentacle on its ectal side. The median tentacle about two and a half times longer than the prostomium; in the type composed of twenty-one articles; only a little narrowing over the distal region. Lateral tentacles considerably shorter than the median. Inferior tentacular cirrus about equal in length to the median tentacle, the upper one much longer and consisting of about thirty-four articles. Neurocirri slender, subcylindric, somewhat conical distally or sometimes a little clavate, surpassing end of parapodium. Notocirri in anterior region alternating in length, the long ones surpassing the width of the body proper and consisting of about thirty-two articles while the short ones embrace only near eigtheen. Notocirri becoming shorter and essentially uniform in the posterior region. Appendage of setae with subapical tooth larger and stouter, more obtuse, than in *alternata,* making a wider angle with the apical tooth, and always conspicuous; the serrations proximad of the tooth fine and rather long. The body is proportionately rather wide and is depressed or flattened, narrowing in the posterior region but retaining there the depressed form. Number of segments in the type, near one hundred and forty-five. General color yellowish; each somite of anterior region crossed transversely by two fine complete lines of reddish brown color.

Width in anterior region, exclusive of parapodia, about 1.25 mm.; length near 20 mm.

Type—M. C. Z. 2, 147.

Taken at low tide.

The type is a female turgid with eggs. It is remarkable in presenting at the same time a well-developed collateral bud from the ventral surface near the beginning of the posterior third.

Pionosyllis pigmentata sp. nov.

Somewhat resembling *P. elongata* (Johnson), which also occurs in this region, but differing in having the dorsum pigmented throughout, being black or slaty with pale lines between the segments and dividing each of the latter transversely excepting across the middorsal region. The pigmentation may sometimes be very dilute. In technical details readily distinguished from that species, e. g., in the different form of the appendage of the setae, this being obviously more elongate and erect and proportionately more slender. Two or more dorsal setae differ in having shorter, more strongly curved appendages which are wholly smooth on the concave edge instead of being pubinate to beyond middle as in the others. Prostomium rather short and

broad. Palpi thick the ectal lobe small as compared with the principal or mesal one; united only at base. Eyes small, transversely elongate and often curved, the two on each side close together and sometimes almost fused, with the posterior one well mesad of but only a little caudad of the anterior one. Median tentacle situated midway between the two eye groups in a longitudinal furrow dividing prostomium; composed of eighteen to twenty-three short articles. Each paired tentacle at corner of prostomium in front of eye-group of corresponding side; similar in form and size to the median tentacle. Lower tentacular cirrus about equalling a tentacle in length, the dorsal longer, both of similar form. First segment extending forward in a rounded or subtrinagular lobe or flap at middle above. The notocirri attached above bases of parapodia as usual; long, composed of numerous short segments; much longer than the tentacles, each average one when laid back along body ordinarily passing over three or three and a half segments. Neurocirri short, stout, fusiform. Body slender, narrowed moderately at the ends, elsewhere of nearly uniform width. Type composed of seventy-three segments.

Length, near 20 mm.

Type—M. C. Z. 2, 148.

Littoral zone.

Fionosyllis lucida sp. nov.

Readily differentiated from *P. elongata,* which it resembles in its pale, translucent appearance, in having the distal appendage of setae more typical, being of a decidedly more elongate and erect form which also differs from that of *pigmentata.* From the latter differing conspicuously in appearance in lacking all dark pigment. Notocirri tapering distad, with apical region slender and pointed; long, exceeding the width of the body and consisting of up to forty-five articles. Differing from *pigmentata* in the form of the neurocirri which are more uniform in diameter, subcylindric rather than fusiform; normally extending more or less beyond the tip of the parapodium. Prostomium short. Eyes reddish; those of first pair larger than the second; second eye on each side almost directly mesad of the first but only a little caudad of it. The median tentacle farther forward than in *pigmentata,* well in front of the eyes, its anterior edge being nearly in line with the caudal margins of the paired tentacles; composed of twenty-eight or more short articles. Paired tentacles much shorter and also more slender; composed of about twenty articles. Palpi fused at base as usual; narrower distally than in *pigmentata.* The types are incomplete caudally; but the body is evidently slender. One specimen 8 mm. long consists of forty-three segments; and a second, somewhat thicker one, of nearly the same length consists of thirty-seven. The width is near 1 mm.

Type—M. C. Z. 2, 180.

Hesperalia gen. nov.

Palpi thick, fused at base only to middle of length. Pharynx straight. Proboscis unarmed (?). Tentacles three, attenuated, more or less obviously jointed. Eyes two pairs; large. Tentacular cirri two pairs. Parapodia uniramous with setae all compound, or in the epitokous phase with long simple natatory setae in notopodia of middle region of body. Appendage of compound setate short, bidentate. Neurocirri present, thick, rounded. Notocirri on side of body above parapodia; filiform; more or

less segmented. A large quadrate membrance or flap projecting from anterior edge of peristomium forward over caudal region of prostomium.

Genotype.—H. californiensis sp. nov.

Hesperalia californiensis sp. nov.

Body rather stout for a syllid, more as in Hesionidae; broadest and deepest anteriorly, continuously narrowing caudal to the pointed posterior end. The color of the dorsum is blackish, with pale transverse lines in the intersegmental furrows and bisecting each somite which under the lens thus appears double. Parapodia and cirri typically pale fulvous and the venter either similar or approaching the dorsum in color. Prostomium very short, sunk in the first body ring and almost completely overlapped by the quadrate flap from the latter, this flap extending over the bases of the tentacles in the type. Palpi stout, presenting two main lobes fused to their apices or nearly so, and on each of these an ectodistal lobe projecting ventrocephalad, these distal lobes wholly free from each other. Tentacles appearing nearly smooth; tapered; the median exceeding the lateral in length. Eyes large; in type orange colored; the two on each side contiguous or nearly so; posterior ones nearer together, each beneath edge of the quadrate peristonial flap, while the anterior ones are in line with base of median tentacle. Tentacular cirri of same form as tentacles but longer. Neurocirri thick, short, distally rounded. Natocirri long, filiform, tapering distad, weakly ringed; showing a tendency to alternate in height on the sides of the body, the first being notably farther duisad than the second, the third than the second and fourth, etc. Setae numerous; the appendage short, falcate, with tip simple, but a slender tooth near middle of curved edge. Segments short, crowded, near one hundred in number.

Length of type, 21 mm.; greatest width, 2.2 mm.

Type—M. C. Z. 2, 149.

Taken in August, 1914.

Hesperalia nans sp. nov.

The type of this species is in the epitkous phase. The middle region of the body bears notopodeal fasciae of long, fine, simple, natatory setae in addition to the compound neuropodials. The appendage of the compound setae differs from that of *californiensis* in having the accessory tooth farther distad, well beyond the middle of the concave edge, whereas in the other species it is normally rather proximad of the middle. In the present species the prostomium is proportionately larger, less covered by the peristotmial flap which does not extend over the base of the median tentacle. The palpi are not fused so far distad, being unitd only at base; they present below on each a large distal lobe similar to that in the other species. Eyes with prominent lenses; large; those on each side sub-contiguous. Median tentacle in line with the centers of the anterior eyes; short and pointed, shorter than the width of the prostomium. Paired tentacles a little shorter than the median; each attached in front of the median at a point midway between the latter and the anterior eye. Tentacular cirri much longer than the tentacles, attenuated distad, pointed. The notocirri are all similarly attenuated and run out to a rather fine point. Neurocirri very thick, conical, each with a black dot near middle. Contrasting with the preceding species in color in having the dorsum in general light, fulvous, in part slightly dusky, with a series of dark, blackish, transverse lines across dorsum, there being four somites between each two dark lines. The body is narrowed toward both ends; venter flat and dorsum

strongly arched; hesioniform. Because of the broken condition of the type the number of segments is uncertain, but is near seventy-five.

Greatest width, exclusive of parapodia, 1.5 mm.

Type—M. C. Z. 2, 150.

Dredged August 27, 1917.

Campesyllis gen. nov.

Like *Streptosyllis* in having the pharynx strongly sinuous and unarmed and in lacking nuchal flaps such as characterize *Amblyosyllis*. It differs from the former genus in having only composite setae and in having these of the ordinary structure, the appendage of a simple, fringed form not covered by a membrane. Eyes two pairs instead of three. Tentacular cirri two pairs. These, as also the tentacles and notocirri, short, articulated. Neurocirri attached proximally.

Genotype.—C. minor sp. nov.

Campesyllis minor sp. nov.

The type of this small form is only 2.5 mm. long. The pharynx is strongly sinuous. The palpi are contiguous throughout and are fused for most of length though a median furrow or sulcus above and one below run to base; projecting forward; together they narrow distad, with outline triangular; shorter than prostomium. Eyes two pairs, well separated, subequal, forming a nearly straight transverse row a little in front of the peristomium. Median tentacle attached far back between posterior eyes; short, a little exceeding prostomium and palpi together. Lateral tentacles also short, each attached at cephaloectal corner with the prostomium bulging forward between them. Tentacular cirri and notocirri also short, the latter in anterior region about equalling half the width of the body proper and not extending much beyond the tips of the setae; joints short, near fifteen or less in number. Neurocirri subcylindric, slender, reaching ends of parapodia. Setae transparent; end of shaft but little enlarged, its articular edge very oblique; appendage long and slender, the tip curved, the edge strongly fringed. Body ventrally flat; convex dorsally, strongly narrowed caudad.

Taken in a sabellid colony.

Type—M. C. Z. 2, 151.

NEREIDÆ

Nereis latescens sp. nov.

Allied to *N. vexillosa* (Grube) but a much smaller species readily distinguishable superficially through the presence of purplish markings on the prostomium and anterior segments, by the form of the appendages, and particularly by the presence on region V of the proboscis of a single large conical tooth such as is present in various epitokes. The prostomium is marked above by a large purplish area germinate by a narrow median longitudinal yellow line. Eyes black. On the anterior segments, above on each side a transverse purplish stripe along anterior and one along posterior border and across the dorsal region, a shorter but broader stripe a little in front of the middle of segment. The body otherwise yellowish. Eyes exceptionally large, and those of each side very close together. Tentacles close together, slenderly cylindrical, moderately narrowing distad, shorter than prostomium and not extending beyond end of proximal joint of palpi. Paragnatha in general as in *vexillosa;* area I with but a single tooth; II, III and IV with numerous teeth in a patch on each; V with a single exceptionally large tooth; VI with four teeth in a quadrangle; VII and VIII with teeth

in a band across ventral and lateral surface in which the proximal ventral teeth are smaller than the distal as in *vexillosa*. Peristomium shorter than prostomium and than the next two somites combined; divided by a transverse furrow. Tentacular cirri short; the ventral ones subequal, less than half the length of the dorsals, which are also nearly equal to each other; more or less flattened; cirrophores short. A typical parapodium presents three stout conical lobes additional to the setigerous ones; of these the dorsal one in the anterior region is stoutest, but becomes more slender in the posterior region. Both notocirri and neurocirri proportionately very slender. Anal cirri about as long as the dorsal tentacular cirri, flattened.

Number of segments, sixty-two.

Length of types, 20 to 23 mm.

Type—M. C. Z. 2, 152.

Taken among hydroids.

Nereis mediator sp. nov.

This species also resembles *N. vexillosa*, though apparently a normally much smaller form. It is, so far as evidence at present accessible to me indicates, distinguishable from that species in having a narrow band across the anterior border of the dental band of VII composed of much finer denticles instead of having the anterior teeth large and the posterior ones reduced. The paragnatha are fewer than in *vexillosa*, those of II, e. g., being in fewer (usually three), less oblique and more separated series and those of VI in all the typical specimens being three in a triangle or four instead of from six to nine or more in a crowded patch. No colored markings. The tentacles proportionately thicker and obviously closer together. Tentacular cirri shorter. Notocirral laminae of the middle and posterior regions much less elongate and flattened with their ventral conical lobe much more pronounced throughout, more as in the smaller specimens of *vexillosa*. Anal cirri short. Number of segments up to seventy.

Length, to 60 mm.

Type—M. C. T. 2, 153.

This is doubtless the same form as recorded by Dr. Moore from San Diego as *N. vexillosa* in Proc. Acad. Sci. Phil., 1909, p. 244. It is undoubtedly close to that species; but as all the specimens which I have seen, and apparently also those studied by Moore, differ constantly in the features above mentioned from specimens of *vexillosa* from more northern localities on the Pacific coast, etc., the form is maintained as distinct. A single heteronereis female is among the specimens from Laguna Beach.

LEODICIDÆ

Leodice monilifer sp. nov.

Yellow in color, Body strongly narrowed caudad. Prostomium short and broad. The palpal lobes large and rounded, bulging conspicuously forward and ventrad; separated by a deep furrow. Tentacles in a slightly curved transverse line, the outer paired tentacle on each side lying a little farther forward than the inner. Ceratophores very short and not broader than bases of styles, exceeded by the first segment of style which about equals the next two in length. The styles in general strongly moniliform, the articles short and well rounded. The styles in types short but not in any case certainly complete; the number of articles present from nine to twelve. The peristomium much longer than the prostomium than which it is also clearly wider and

higher; entire second somite very short, not more than one-fourth as long as I. Nuchal cirri short and conical, much shorter than the peristomium, transversely wrinkled or sometimes distinctly annulated. Notocirri slenderly conical, becoming more slender in posterior region as usual; with some weak encircling wrinkles but not distinctly divided into articles. Branchiae begin as single filaments on IX or sometimes on VIII. Branchiae of X each consisting of two filaments. The number in several of the succeeding branchiae increases to three, then again falling to two, and, finally, the last eight pairs or so are again simple filaments. The last branchiae in the type occur on XXXII. Anal cirri short, slenderly conical. Moxillae strongly chitinized; brown, with edges in part black. In maxillae II the right plate has six large teeth, the outer left plate four and the odd or inner left plate seven or eight. III with nine teeth or crenulatious. Number of segments in type one hundred and nine.

Length, 43 mm.; greatest width, exclusive of parapodia, 2.6 mm. An incomplete larger specimen has a width of 3.2 mm.

Type—M. C. Z. 2, 154.

Taken among holdfasts of kelp. (C. F. Baker, June 30, 1911.)

Arabella lagunae sp. nov.

As compared with *A. attenuata* Treadwell, this is a smaller species differing in appearance in being brown of a decided greenish tinge, excepting on the prostomium and at the caudal end. The prostomium is less narrowed cephalad, being more broadly rounded across anterior end. Median eyes not exceeding the lateral in size. Maxillae V represented by simple small hooks. IV with five teeth of which the most ectal (upper) is long and slender, the two next much shorter and finer and the two innermost closer together. III with fine teeth similarly arranged and formed. Maxillae II nearly symmetrical; the left one with seven teeth of which the most anterior one is much largest, the right with an additional small tooth in front of (ectad of) the large one; neither of the plates extending caudad of the anterior end of the dental series of I. I with seven or eight well developed teeth; the carriers very long and slender, black throughout. In the paraphodia the posterior lobe is well developed, stout and conical, distally somewhat blunt or rounded, extended ectad or caudo-ectad and is always shorter than the setae. Setae all simple, limbate, in a single series of mostly six in the middle region of the body. Setae with the usual double or sigmoidal curve over the limbate part, the first bend or geniculation unusually strong, angular; tip becoming fine and hair-like. Body tapering caudad, pointed at the posterior end, ending in two blunt lobes. Number of segments in the type one hundred and ninety-one.

Length, 46 mm.; width, exclusive of parapodia, 2 mm.

Type—M. C. Z. 2, 155.

Taken at the shore "under rocks."

Arabella mimetica sp. nov.

Resembling the preceding species though smaller and more slender. Superficially differing obviously in the form of the prostomium which is much more narrowed distad and is neither depressed nor furrowed either dorsally or ventrally. Eyes smaller, obscure. Maxillae resembling those of the other species in general, but differing strongly in the second pair in which the right plate, instead of being symmetrical with the left one, is decidedly long and extends far proximad along the dental line of I and bears about fifteen teeth as against only six on the left one and eight on the cor-

responding plate in *lagunae*. Maxillae I on right side with nine teeth, on left apparently with seven. Maxillae III with teeth in arrangement as in *lagunae* but only four in number and different in all being blunt and shorter. IV as in the other species but teeth four instead of five. The number of segments in the type is near one hundred and sixty-five.

Length, 40 mm.; width, 1.1 mm.

Type—M. C. Z. 2, 156.

Taken among holdfasts of kelp. (C. F. Baker, June 30, 1911.) Also a small specimen taken August 2, 1917, by Prof. Hilton.

Biborin gen. nov.

Setae all simple, limbate, well developed. First two segments achaetous. Eyes none. Maxillae absent, but the mandibles normally developed, the wall of the alimentary canal opposite the latter simply thickened. Notocirri rudimentary.

Biborin echola sp. nov.

Biborin echola sp. nov.

The type as preserved is greyish brown of a dull bluish green cast. A note with the specimen also states that it is greenish in life. The body is strongly attenuated and pointed caudad, more moderately cephalad. The prostomium larger than wide and somewhat longer than the first two segments; subconically narrowed distad, apically rounded, flattened dorsoventrally. The two achaebous segments subequal in length or the second slightly longer, not produced forward below. Mandibles short and broad, not toothed, the edges meeting at an acute angle in front; the caudal stems shorter behind point of separation than the blades in front of this point, rather slender, blunt behind. Posterior lobes of parapodia subcylindrical, a little conically narrowed distad but with apex well rounded, extending ectad or caudoectad; in middle region of body reaching to or a little beyond middle of longer setae, the setae relatively shorter in anterior region. Setae all simple and limbate with the usual double curve, the first curve or angulation obviously less marked than in *A. lagunae*, which form this species superficially resembles. Number of segments in type, two hundred and seventy-seven.

Length, 92 mm.; width without parapodia, 2.2 mm.

Type—M. C. Z. 2, 157.

Taken among Phyllospadix, September 17, 1917.

GLYCERIDÆ

Glycera exigua sp. nov.

A small species easily recognizable among the known forms of the California coast by the character of the parapodia. Each of these present three lips, two anterior and one posterior; all three lobes triangular, pointed distad, with the posterior one fully equalling the other two in length. The neurocirrus is also triangular in outline. The natocirrus is reduced to a small rounded or nodular form slightly above base of parapodium. Branchiae simple cylindrical filaments, each attached toward distal end of parapodium above as in *G. alba* and *G. longipinnis;* the first occurring on or near somite XXX, short, in actual length not greater than parapodium exclusive of terminal lips and falling much short of reaching ends of setae; absent from last twelve segments or so and those just in front of this caudal region much reduced. Prostomium of usual general form; consisting of fourteen or fifteen rings. Proboscis

long; weakly longitudinally ridged and densely finely papillose. Body strongly narrowed from the anterior region caudad, the caudal end slenderly pointed. Segments biannulate. Number of segments in the type near one hundred and thirty.

Length, 26 mm.; width, 1.5 mm.

Type—M. C. Z. 2, 158.

Balboa, December 26, 1917.

Glycera basibranchia sp. nov.

Resembles *exigua* in having the branchiae in the form of a series of single, simple filaments but readily distinguished in having each branchia attached at base of parapodium on the dorsocaudal surface just ectad of the notocirrus instead of at the distal end above. The branchiae begin on the twenty-ninth setigerous somite and continue to about the one hundred and twenty-ninth, decreasing in size at the two ends of the series. In the middle region they are cylindrical, distally rounded, and transparent, and at most do not surpass the distal end of the parapodium, most of these being obviously shorter than this in the preserved specimen. Also decidedly different from *exigua* in having four lobes at the distal end of each parapodium, two postsetal and two presetal. These are narrowly triangular, distally pointed, with the presetal lobes thicker and more conical and decidedly longer than the postsetal. The short, distally rounded notocirri are attached at the base of the parapodia above in the angle between the latter and the body wall. Neurocirri distally subcylindric, resembling the distal parapodial lobes. The prostomium disinctly ringed to near middle, the basal half showing five rings while the distal half in the type is only vaguely annulate, though with indications of apparently seven nearly fused rings, making the total number twelve. Proboscis long, densely papillose. Type incomplete caudally; one hundred and forty-five segments retained.

Length (not quite complete), 36 mm.; greatest width, 1.3 mm.

Type—M. C. Z. 2, 159.

A note gives the color in life as light, the red blood showing through as usual in the family.

Glycera verdescens sp. nov.

A very small form differing from the two preceding in wholly lacking branchiae. The parapodia are strikingly different in that the postsetal lobe is either wholly absent, as in anterior region, or is represented by a single, small, pointed process, while there are two presetal lobes which are long and subcylindrical or finger-like and of which the ventral one is ordinarily the larger. The notocirrus is small and occupies the usual place in the angle between the dorsal surface of the parapodium and the body-wall. Neurocirrus slenderly conical, darkened distad as are also the presetal lobes. The slenderly conical prostomuim showing twelve annuli. Type at present showing a distinctly greenish tinge. Type incomplete caudally, sixty-nine segments retained, the length being 13 mm., width, 1.1 mm.

Type—M. C. Z. 2, 160.

ARICIIDÆ

Nainereis hespera sp. nov.

This is apparently a smaller species than *longa* or *robusta* and is composed of fewer segments. It differs from those species in having the anterior division of the body composed of only nineteen segments and in having the first branchiæ appear on

the thirteenth or fourteenth segment. The prostomium is broadly subtrapeziform, narrowing forward and with the anterior margin varying from slightly convex to mesally indented as is the case in the type; dorsal surface nearly flat, simply marked with two furrows, or sometimes with the median caudal region between furrows elevated. Peristomium with anterior margin above more or less concave, its median length about equal to that of the second segment, which is also ordinarily bowed caudad. In the neuropodia of the anterior region the postsetal processes are broad, distally rounded, thick lips which are prominent; in the posterior region these become narrowly conical, elongate, distally pointed processes. The postsetal processes of the notopodia in the anterior region are thick, short cones which increase in length in going caudad, in the posterior region being very elongate. The branchiæ begin on the thirteenth or fourteenth segment as short processes but become abruptly longer, basally thick and distally pointed processes much thicker than the postsetal processes of the notopodia and exceeding these in length; they are widely separated and, while curving in somewhat mesad, do not come in contact, leaving much of the mid-dorsal region naked. They continue to the end of the body. The neuropodial setæ of the anterior region are arranged in three subvertical series and form a patch twice as high (dorsoventrally) as long (cephalocaudally). The stout setæ of the posterior row are mostly four in number, less commonly three or five. These coarse setæ are not at all clavate as in elongata and are not roughened or cross-ridged above the curve as in robusta; the terminal region above the curve longer than in the later species. The setæ of the other series are more curved than in robusta and are abruptly contracted farther from the body, the contraction stronger but the one edge similarly roughened or denticlated with cross lines. At the ventral end of the series a small patch of ordinary, camerated, capillary setæ resembling the notopodials. The body is broad anteriotly and narrows to the posterior end. Dorsal surface flat and the ventral convex as usual. Number of segments in the type one hundred and thirty-six. Color in general pale brown; at black spot at base of each branchia at least those of posterior region, in front and behind and the proximal part of branchia often darkened.

Length, 27 mm.; greatest width, 2.4 mm.

Type—M. C. Z. 2, 161.

Scoloplos acmeceps sp. nov.

Resembling *S. armiger* (O. F. Müller) in general structure. A less deeply pigmented species easily distinguished from this northern form in wholly lacking the ventral papillæ (neurocirri) present in the latter below the parapodia of about the eighteenth to thirtieth segments. The prostomium is similarly elongate and pointed but is more slender; it is borne at the end of the peristomium which has the form of a truncate cone. The branchiæ begin anteriorly in the same way as very slight elevations and increase quickly to long ligulate forms; but the first one appears on the sixteenth or seventeenth setigerous segment instead of on the twelfth or thirteenth as usual in armiger. The fully developed branchiæ are obviously narrower than typical for the latter species. The lobes of the parapodia are in general similar though they do not become obvious so far forward. In the second division of the body the ventral lobe is similarly elongate and bifid at the tip with the inner or more dorsal lobe the longer; but the lobes are characteristically more divergent, thinner and more slender. The first bifid neuropodial lobes appear on the twenty-first setigerous segment. The

dorsal lobe similar in form to that in armiger. Caudal end of all the types missing.

Greatest width, 2 mm.

Type—M. C. Z. 2, 162.

Balboa (Sept. 10, 1917).

FLABELLIGERIDÆ

Flabelligera haerens sp. nov.

This species resembles F. *commensalis* Moore in the approximation of the neuropodia though these are apparently not so close as in that species and are at no place actually contiguous though nearly so in the extreme caudal region. In front of this they remain a uniform distance apart, which is less than the length of a somite, forward to about the tenth somite from where the rows diverge gradually forward. The notopodia more widely separated, the rows diverging cephalad from near the tenth somite, always much closer to each other than to the neuropodia. Ventral surface flattened or weakly concave, the dorsal surface also flattened but slightly convex, while the sides are convex; the body in part is slightly compressed from side to side, in cross-section subquadrate to subcircular; widest in middle region and narrowing both ways, more strongly so caudad, subfusiform. Collar lobe deeply and widely incised dorsally and ventrally; the lobe on each side bearing a series of numerous long cross-striated setæ which are reddish brown in color and are stouter than the ordinary notopodials. The notopodials are simple, finely tapered, colorless setae. There is a single seta in each neuropodium, this being in the form of a very stout hook; the color is dark throughout; the transverse terminal portion of the hook is longer and more slender and acute than in commensalis and the pseudo-joint is farther proximad of the curved region; the shaft is bent caudad at the level of the joint, the hook proper curving mesad. The entire surface is densely papillose. The setæ of the collar are cloaked by a dense growth of long filiform papillæ with large clavate tips, these papillæ approximating the setæ in length. The papillæ also cluster densely about the notopodia, these papillæ having similar clavate tips. The papillæ of the general surface of dorsum, venter and sides are much shorter. Color nearly uniform greyish brown. Number of segments in type, forty-nine.

Length, 13 mm.

Type—M. C. Z. 2, 163.

Taken in holdfasts of kelp, August 12, 1917.

CAPITELLIDÆ

Natomastus angulatus sp. nov.

In comparison with N. tenuis Moore, known from San Diego, this species differs in the form of the thorax, which is strongly angulate instead of terete the sides and venter being flat and the dorsum usually but little convex, so that the cross-section is nearly quadrate; also in having the segments and their subdivisions sharply separated with the posterior subsegment in each case much shorter than the anterior instead of equal to it. In the type the posterior thoracic somites are twice or more as long as wide, but in some paratypes the relative length is much less. Thorax narrowed caudad. The abdomen in its anterior part obviously thicker than the thorax in its widest part. The prostomium characteristic, showing two distinct regions, a broad posterior one with convex, anteriorly converging sides and a narrower, subconical, palpoidal ter-

minal part sharply set off from the basal. Segments of abdomen irregularly multiannulate, sulci deep and surface usually appearing strongly rugose and uneven.

Length near 160 mm.; greatest width of abdomen, 1.4 mm.

Type—M. C. Z. 2, 164.

Taken in sand and in growths of eel grass. The color is noted as reddish in life, as usual in the family.

SPIONOIDEA

Morants gen. nov.

Body with an anterior region of fifteen setigerous somites separated from a larger posterior region by a specialized somite, the sixteenth. Prostomium with a lateral process or horn on each side in front, notched in front at middle. Eyes none in genotype. Dorsal cirri present in addition to branchiæ on the first four setigerous somites. Notopodia with simple capillary setæ throughout. Anterior neuropodia with capillary setæ, but others also with crochets. Anal. cirri two.

Genotype—M. duplex sp. nov.

Morants duplex sp. nov.

Palpal processes lost from type. Proboscis as protruded short, distally expanded over proximal region. Parapodia dorsolateral in position, the anterior ones very thick. Principal postsetal lobe rising above into a branchial process which is short anteriorly but in posterior region is much longer, slender and subulate. Mesad of the branchial process of each parapodium of the first four pairs is a cirrus or cirriform process. The inferior setæ of the most anterior parapodia much shorter than the dorsals, strongly curved. In the first notopodial fascia a much stouter, aciculiform, setæ which is uncate. Crochets with strongly narrowed neck; with two curved teeth at distal end above the beak which is decurved; in posterior region few in number, commonly four in a series. Anal cirri slender, filiform, much longer than the preceding branchiæ; one in the type has a short spur near its base. Total number of segments about one hundred and sixteen.

Length, 21.5 mm.

Type—M. C. Z. 2, 165.

Balboa.

The tubes adhere closely to the body. Their walls of fine sand.

AMPHARETIDÆ

Schistocomus gen. nov.

Like Phyllocomus in lacking tentacles and postbranchial spines, in bearing fifteen pairs of fasciæ of capillary setæ and four pairs of branchiæ. It differs from that genus in having the branchiæ of two types, one pair being of the ordinary, smooth, simple, subulate form and the other three with the edges divided, two pinnately, bearing two close series of lamellar branches, and one with an essentially single series of branches in the genotype.

Genotype—S. hiltoni sp. nov.

Schistocomus hiltoni sp. nov.

The body has the ordinary general form, being widest near the fifth setigerous segment from where it narrows continuously to the slender, pointed cauda. Dorsum convex, venter less so, the latter with a double median longitudinal furrow in the

posterior region. Prostomium projecting forward as a simple hood with rounded anterior corners and the median region of anterior edge nearly straight; dorsal surface in type longitudinally wrinkled. Ventrally the peristomium projects forward between the sides of the prostomium in a conspicuous lobe or lower lip which narrows somewhat distad and has the distal margin convex; surface longitudinally wrinkled. Second somite achaetons. The third bearing the first fasciæ of simple setæ, the sixth the first uncini. Of the pinnate branchia one pair occur on the third setigerous somite and one on the second while the branchiæ with single series of branches in which the branches are less lamellate, are on the second (first presetal) somite, the simple branchiæ arising on the first setigerous somite. The first branchiæ are attached near the middle of the dorsum, the others laterad close above the parapodia. The first and especially the second or simple branchiæ extending forward beyond the anterior edge of the prostomium. Color light fulvous or in part greyish. Number of segments near fifty-five.

Length, 22 mm.; greatest width, 3 mm.

Type—M. C. Z. 2, 166.

Taken at Laguna Beach Sept. 15, 1917.

The tube in which the type was found is 35 mm. long. The wall is thickened by the adhesion of fine particles of sand, fragments of shell, etc.

TEREBELLIDÆ

Leaena videns sp. nov.

The prostomium extends as a convex hood or inverted scoop above the mouth; along its posterior border is a series of long, crowded, tentacles. The prostomial fold behind the tentacles is crossed by a transverse band of distinct eyes, the band narrow above and widening on each side. Mouth a crescentic slit with corners curved caudad; bordered behind by a thick lip the anterior median edge of which is truncate. No dorsal cirriform process on III or any other segment, all being wholly smooth. A characteristic of the species is the large number of setigerous segments, at least thirty-one being present (IV-XXXIII) in the type, and possibly more. The setæ differs from those of *nuda* in their longer fine tips and more geniculate appearance at base of this region. The uncini are characterized by an exceptionally long beak which, beyond its strongly curved base is straight; the sinus narrow, the process arising near its middle, low obtuse; vertex not comparatively high, crossed by mostly four series of denticles; body of uncinus rather narrow, the shoulder on convex side much farther toward the end than, e.g., in *nuda* and well below level of bottom of sinus. The type is incomplete, only near thirty-eight segments being present. The color is noted as pinkish in life. At present it is fulvous in the type.

Length of incomplete specimen not in excess of 12 mm.; greatest width, .8 mm.

Type—M. C. Z. 2, 167.

Pista fratrella sp. nov.

This form seems to be close to P. *alata* Moore. The type, which is much smaller than that of *alata*, differs in various details from the description of the latter. The principal lateral wings are confined to the third segment and are united across the dorsum of third somite instead of involving the anterior border of IV and crossing the latter above; connecting dorsal fold low and lacking any forwardly directed process; the wing rises as a high, rounded lobe on each side just below level of setigerous

tubercles, rising high above the middorsal surface. In addition to the prominent wings on III there is on IV on each side a much lower ridge or wing paralleling that on III, this not more prominent above. Unlike those of *alata*, somites II and III are not confounded laterally but are distinct throughout. Prostomium short. Tentacles mostly lost in type; rather slender, not long, apparently in but a single transverse series. Peristomium deeply excavated at middle below, the bottom of the excavation rounded and the peristomium produced on each side of this into the usual large lobes. The branchiæ, as in the genotype and other species, strongly asymetrically developed. The right anterior branchia is much the largest, the trunk very long, with the left anterior much smaller. Of the posterior pair, the right, unlike that of *alata*, is also much larger than the left one. In the type the sternal plates are not sharply differentiated. The manubriate uncini of V have the general form of those in *alata*, but the bulge below the beak is much larger and more rounded with the subrostral tooth more obtuse and nearer the middle of the oblique edge; beak less divergent from manubrium; vertex with three transverse series of denticles. The color in the abdominal region light fulvous, in the thoracic darker with a narrow brownish stripe along caudal border of each segment laterally and ventrally. Type not quite complete caudally, retaining eighty somites.

Length, 36 mm.; greatest width, 2.8 mm.

Type—M. C. Z. 2, 168.

The wall of the tube is composed of sand and shell fragments.

Naneva gen. nov.

Prostomium short; with numerous tentacular filaments. Uncini avicular and of same form throughout. Setæ beginning on third somite; tips simple. Uncini beginning on the fourth somite. No lateral foliaceous lobes on the anterior segments. Branchiæ two pairs; branched; attached on somites II and III.

Genotype—N. hespera sp. nov.

Differs from Thelepus and Athelepus in having the branchiæ branched instead of simple and in having the uncini begin on IV.

Naneva hespera sp. nov.

The prostomium forms a prominent upper lip of which the anterior border is turned upward all along, leaving a deep concavity between it and the upcurving posterior fold along which the tentacles are attached. Because of their curled and tangled condition the precise number of tentacles was not ascertained, but is about twelve on each side; they are long, some when fully extended being 15 mm. in length. No eyes were detected in the type. Peristomium forming a lower lip of but moderate length with straight anterior edge; scarcely twice as long as the second somite below. First branchia on each side attached to second somite just in front and mesad of the first setigerous tubercle. The second branchia attached just caudad of the first on the caudal region of somite III. Both branchiæ very similar, each presenting three principal branches of which the most mesal is largest; ultimate branches numerous, rather short. Capillary setæ beginning on III and continuing to XXVII. The anterior setigerous processes are in the form of vertical plates with straight truncate, distal edge; but in going caudad these become reduced finally to slight tubercles, with the first about equal to half the intervening space and by the seventh equal to this space, while in the abdominal region the opposite series are separated merely by the median furrow. Anterior ventral plates strongly longitudinally furrowed. Capillary setæ

narrowly bilimbate, drawn out into a very fine simple tip. Uncini, at least for the most part, in two series both in thoracic and in abdominal region; apparently with mostly three transverse rows of denticles at vertex; beak long, the sinus with parallel sides, opposite side of body evenly curved, not distinctly shouldered. Total number of segments in the type, which is complete, about one hundred and thirty, of which II to XXVII are setigerous. Body rapidly narrowed to the eighteenth segment, but only very gradually thereafter.

Length, near 45 mm.; greatest width, 1.8 mm.

Type—M. C. Z. 2, 169.

Balboa.

SABELLIDÆ

Myxicola monacis sp. nov.

In size and general appearance resembling M. pacifica Johnson, with the type of which it has been compared. From that form the present one may readily be distinguished in having the ventral median process from the first segment drawn out into a slender entire tip instead of being broad and presenting distally two angles or lobes; the process is furrowed longitudinally and the edges are somewhat turned down. Branchiæ twenty-two pairs. Readily distinguished by the form of the abdominal uncini. These have the general form of those of *pacifica* but as a whole are longer with the body proportionately more slender and its abvertigial end more rounded; the beak is longer and less divergent, distally curving a little back toward the body; the sides of the sinus parallel. The body in the type is somewhat fusiform, being narrowed both ways from the middle but more strongly so caudad. In a paratype the body is scarcely narrowed cephalad. Body somewhat depressed dorsoventrally, less terete than in pacifica. Total number of segments near seventy.

Length of type, exclusive of branchiæ, 40 mm.; greatest width, 6.2 mm.

Type—M. C. Z. 2, 170.

Taken from holdfasts of seaweeds.

Potamilla clara sp. nov.

The body in general light brown; but ventrally there is a median longitudinal fulvous stripe over the ventral plates. The branchiæ are crossed by a series of dark bands or annuli which fade out proximally, about three distad of the middle of length being deep and distinct. There are nineteen pairs of branchial radioles; barbs numerous, densely arranged to near tip, the naked distal region of axis very short, pale excepting where partially or completely involved by the transverse dark bands. Ventral lobes of collar moderate, rounded, edges a little rolled down; dorsal ends separated; no lateral incisions, being but two-lobed; not produced forward below, lobes rounded and separated. Thoracic segments eight. Ventral plates all rectangular, those of the abdomen divided by the midventral sulcus. Total number of segments, sixty.

Length without branchiæ 21 mm.; length with branchiæ, 28 mm.; greatest width, 3 mm.

Type—M. C. Z. 2, 171.

Taken on beach at low tide.

Potamilla omissa sp. nov.

The general color is dusky or pale brownish with the anterior ventral plates lighter and the branchiæ rather weakly transversely banded with dark. Radioles of

branchiæ in a simple series; seventeen pairs. Collar well developed, produced forward below in two pointed lobes overlapping at the middle. Eight setigerous thoracic somites. Most dorsal thoracic setæ in each fascicle long and finely pointed with wings narrow; the ventral setæ much more numerous, shorter, spatulate, with fine tip. The uncini have the posterior process very short, rounded at the end, much shorter and more slender than the neck, which is rather strongly curved; vertex high and narrowly rounded; beak not strongly depressed. Type incomplete, only seven of the abdominal segments being present.

Length of first sixteen segments, 15 mm.; including branchiæ, 21 mm.; width, 2.5 mm.

Type—M. C. Z. 2, 172.

Potamilla colorata sp. nov.

The type is notably marked with black pigment; the collar membrane crossed with a close series of longitudinal dark stripes, one in line with each radiole and narrowing caudad; the branchiæ crossed transversely with dark bands. Thoracic somites, more notably the anterior ones, with a dusky to black band in front of each uncinigerous torus and a dark spot on the dorsum mesad of the setigerous papilla. The collar with a dark area ventrad and also dorsad of the fascicle. Ground color greyish of light brown cast, lacking the yellow dominating in omissa. Sixteen (or seventeen) pairs of radioles in the branchiæ. Ventral lobes of collar pointed, widely overlapping in the median line, dorsal ends free, projecting toward each other in dorsal groove. Setigerous thoracic somites eight in number. Inferior setæ numerous, spatulate, usually in two series. Total number of segments present about fifty-one, a few of the most caudal being lost.

Length, 25 mm.; with branchiæ, 30 mm.

Type—M. C. Z. 2,173.

Pseudopotamilla paurops sp. nov.

A rather slender species with branchiæ of moderate length. Excepting the eyes with no pigmented markings. Radioles fifteen pairs. Eyes few, not present on all radioles; where present usually but a single one on each radiole, in one case two; the eyes deep purple, variable in side from moderate to small; situated at varying distance between base and middle of length of radioles. Free dorsal edge of branchial membrane with two short obtuse lobes overlapping in the middle line. The dorsal notch in the collar lobe on each side is mesad of the line of setigerous tubercles, wide open, rectangular or slightly obtuse; lobe mesad of notch small, anteriorly rounded, the mesal edge extending into the dorsal furrow; median ventral lobes separated by a narrow incision, short, the ectal edge passing out in an even concave curve to the anterior lateral margin. A characteristic feature of the species is the presence of ten setigerous thoracic somites. Dorsal setæ of the usual two types of which the upper are much fewer spatulate setæ in two series with distal expansion broad and wings asymmetrical, tip short. Total number of segments, seventy-eight.

Length without branchiæ, 31 mm.; with branchiæ, 36 mm.

Type—M. C. Z. 2, 174.

Tube tough, corneus.

Pseudopotamilla parva sp. nov.

The type of this species is a small individual which, as preserved, appears of a uniform dusky color throughout. Branchial radioles fourteen or fifteen pairs; in a

single series, the membrane not being coiled. No eye spots. Collar with ventral lobes proportionately long and acute, the dorsal lobes small and approximate. Notopodial setæ of usual two types; few. Uncini with beak divergent, nearly horizontal, the "neck" short and the edge of body below bulging much as in *Paralaonome japonica*. Body furrowed along each side just above notopodia excepting anteriorly. Ventral plates sharply limited, elevated; all of abdominal plates bisected by the median longitudinal sulcus excepting the first one, which is entire. Total number of somites, fifty-six, of which eight are thoracic.

Length without branchiæ, 12 mm.; with branchiæ, near 15 mm.

Type—M. C. Z. 2, 175.

Taken among tufted algæ, June 25, 1911 (C. F. Baker).

Pseudopotamilla lampra sp. nov.

In this form the collar membrane is crossed by a series of longitudinal dark stripes, one in line with each radiole, as in *Potamilla colorata*, these narrowing caudad. Branchiæ sometimes mostly dark with light transverse bands. Anterior thoracic segments darkly pigmented both above and below, and also along both sides of tori, and most setigerous papillæ and tori of succeeding regions of body also surrounded in some degree with a pigmented area. Branchial membrane with free dorsal edges produced into two lobes on each side, the two of each pair overlapping, the posterior lobe rounded, the anterior angular with its caudal margin transverse and the other long and oblique. Radioles nineteen pairs, several of these at dorsomesal end of series much reduced. Eyes conspicuous but few, only one, or occasionally two, on a radiole and some radioles wholly lacking them. This species has only seven setigerous thoracic somites. Total number of segments, near ninety-four.

Length, about 28 mm.; with branchiæ, 33 mm.

A note states that this form is pinkish in life. A paratype was taken "in a large white sponge."

Type—M. C. Z. 2, 176.

Pseudopotamilla macrops sp. nov.

While the type of this species includes only the anterior end of the body, its characters seem su....ciently marked for subsequent idntification. As in *lampra*, the anterior segments are darkened with purplish brown pigment, especially adjacent to the setigerous papillæ and about the tori, the ventral plates, however, remaining pale. Branchial membrane also pigmented caudally, and the branchiæ transversely banded. Only two eyes on each side are present in the type, a single one each on the second and third radiole from the dorsal end of the series. These eyes are exceptionally large and prominent, much larger than in any of the other species here recorded, embracing practically the entire width of the stalk. The free dorsal edges of the branchial membrane nearly straight, each with only a very slight angulation near its anterior end, not being truly lobate. Nine pairs of radioles. Minor dorsal lobes of collar prominent, produced well forward, curving a little mesad distally, the mesal edge reflected down the dorsal groove as usual.

Width, .75 mm. Length of branchiæ, 2.5 mm.

Type—M. C. Z. 2, 177.

Pseudopotamilla scotia sp. nov.

Differing from the other species here described in having nine setigerous thoracic somites. Anterior somites of thorax darkened above, down the sides on both sides

of the tori and also more or less ventrally with purplish brown pigment. Processes or lobes on free edge of branchial membrane above almost of same form as in *P. lampra* and similarly overlapping. Nineteen pairs of branchial radioles. No eyes. Ventral lobes of collar prolonged, subacute, not overlapping. In the dorsal fasciæ of the ordinary thoracic somites the dorsal setæ are arranged mostly in more or less single, curved, longitudinal series, the clavate ventrals being arranged in two vertical series at right angles to the line of the dorsals. Pennoned setæ of the uncinigerous tori very prominent. Only a few of the most anterior abdominal segments present in type.

Greatest width, 2 mm. Length of branchiæ, 4 mm.

Type—M. C. Z. 2, 178.

Taken in a large white sponge.

SERPULIDÆ

Eupomatus intereans sp. nov.

This species is separated from *E. uncinatus* (Philippi) with some hesitation since specimens of the latter are not at hand for direct comparison. It would seem, however, to be clearly different, to judge from Ehler's figure, in the form of the uncini. These are much broader (i.e., at right angles to the dental line), the base projecting conspicuously but not forming an angulate shoulder as in *E. gracilis,* being nearly evenly and rather broadly rounded. The teeth are mostly seven in number, the end below the last of these set off as usual, rounded. The upper collar setæ coarse, with two teeth or spurs at base of the slender tip, these commonly more or less unequal in size. Branchiæ thirteen pairs. Operculum in general as in *uncinatus;* width of principal expansion 1.25 mm.; the latter even, by narrowing into the stalk, the rim with thirty-eight projecting acute teeth or serrations which are straight or very nearly so, not at all uncate as in uncinatus in which they are also fewer (thirty). Inner crown of eleven spines each tapered evenly to an acute tip and bent in abruptly toward the center above, the proximal portion being erect and ordinarily parallel with the others. No process or series of processes detected within this crown, the base from which these arise being evenly concave on its distal surface and convex on the proximal. Spines of the inner crown dark brown proximally as is the entire basal plate from which they arise, the remaining part of spines light brown. Operculum proper nearly black below teeth on proximal surface of the expansion and on adjacent part of stalk the remaining part of which is white; distal surface of funnel pale. Branchiæ and body in general pale, unmarked or some of the branchiæ with a blackish mark on stalk toward distal end. Thoracic setigerous somites seven. Abdominal segments, ninety.

Type—M. C. Z. 2, 178.

Length exclusive of branchiæ, 20 mm.; to end of operculum, about 24 mm. Width, 1.5 mm.

The Nervous System of Caecum Californicum

WILLIAM A. HILTON

Specimens of this little gastropod mollosc from 2 to 3 mm. in length were the material for the study. Specimens were fixed and sectioned whole and a few good series were obtained.

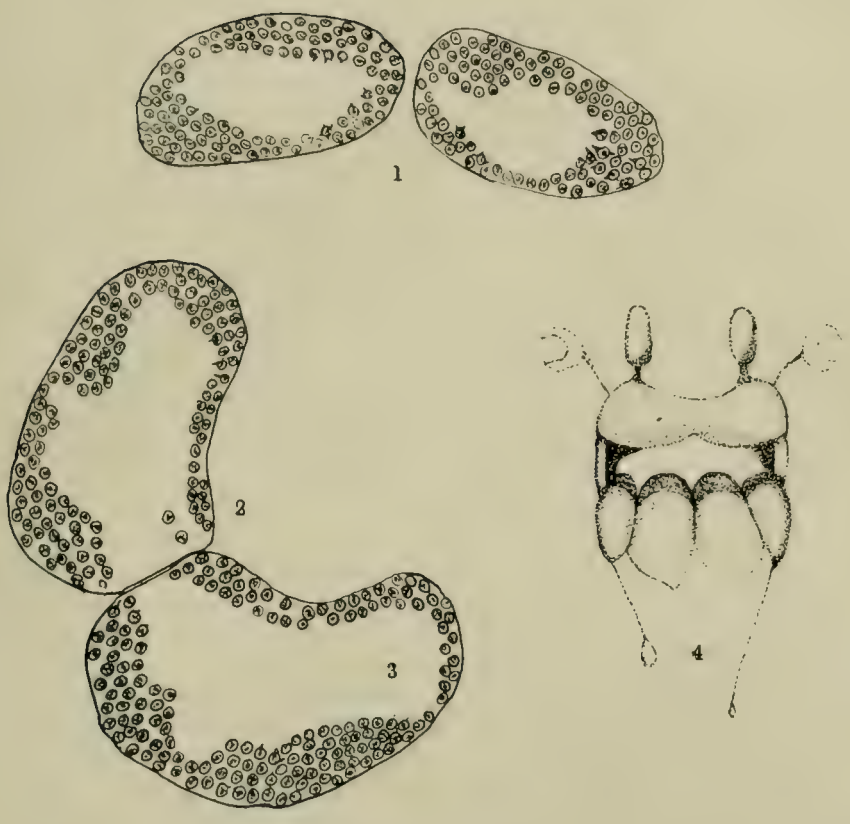
It seems rather remarkable that so small a species should have such a high organization of the nervous system. The ganglia are large in proportion to the size of the animal and well developed. In all cases the exact limits of the nerves and connectives were not determined, but the chief ganglia were easily found.

Quite well towards the head end a pair of buccal ganglia were found, these were small, widely separated and possessed only a few nerve cells. At about this level in cross sections the eyes make their appearance, one on each side. They are simple, quite large and well provided with pigment. Below the level of the eyes and the buccal ganglia, on the dorsal side of the esophagus, the much larger cerebral ganglia make their appearance. These probably are connected with the eyes but the connections were not clearly seen in the sections. The cerebral ganglia are closely united along the middle line. They occupy more than one half the diameter of the entire animal. The more caudal ends of these ganglia separate and run down, a little lateral to the esophagus.

Below the esophagus and a little below the chief level of the cerebral ganglia, a region of more ventral masses of nerve tissue is reached. There are two ganglia on each side, a lateral pair somewhat smaller than the more ventral. The lateral are the pleural and the ventral are the pedal ganglia. The pedal ganglia are closely pressed against each other in the middle line, but not fused, they are much larger than any of the other ganglionic pairs and of a more complicated cell and fibrous structure.

Beyond the region of large ganglia and slightly farther towards the other end of the animal, on the right side, a small visceral ganglion makes its appearance. Farther down on the left side a much smaller group of cells seems to indicate another ganglion of the viscera.

(Contribution from the Zoological Laboratory of Pomona College)



Explanation of Figures

Fig. 1 Camera lucida sketch of cerebral ganglia of Cæcum. The dorsal side is up. X300.

Fig. 2. Left pleural ganglion of Cæcum. X300.

Fig. 3. Left pedal ganglion of Cæcum. X300.

Fig. 4. Reconstruction from Cæcum, showing position of eyes and ganglia viewed from the ventral side. X70.

Amphipods from Laguna Beach

The following list is from the collections of 1917, or that part of it sent to the U. S. Nat. museum for determination.

Aruga oculata Holmes. L. 6 mm., white with red on the head. From algæ. Another white specimen of 8 mm. Dredged at 10 f.

Paraphoxus sp. L. 9 mm. Light colored.

Ipiplateia sp. Red. L. 10 mm.

Lilljeborgia brevicornis Bruz. One specimen dredged Aug. 28. Head white upper half, lower half pink. Lower part of body pink, upper white. L. 6 mm. Another head end of body red, caudal end white. L. 4 mm. Dredged Aug. 11 and Sept. 17th.

Tiron sp. Light colored L. 9 mm.

Elasmopus brasiliensis Dana? L. 6 mm., yellow, brown eyes. Line on back.

Melita quinquedentata Shoem. L. 6.5 mm. Tide pools Aug. 29.

Allorchestes sp. immature. One lot pale green, red antennæ, L. 3.5 mm. One red L. 10 mm. One from holdfasts brown and red L. 6 mm.

Hyalella azteca Sauss. Brown green, 3.5 to 4 mm.

Hyale sp. One red, L. 4 mm. One dark L. 6.5 mm. One pink-brown from sulphur sponge. L. 7 mm. One rose on back, ringed with white. One yellow green back, L. 5.5 mm. One yellow, pink antennæ, holdfast L. 11 mm. One brown from algæ L. 5 mm. One rose brown L. 6 mm.

Orchestoidea corniculata Stout. Green grey, bluish antennæ L. 14 mm.

Lembos sp. bands on body. L. 6 mm. From holdfasts.

Microprotopus sp. Bands on body L. 6 mm.

Photis californica Stout. Bands on body. Holdfasts.

Neophotis inequalis Stout. Brown and red. L. 6 mm. Holdfast.

Amphithoe corallina Stout. Yellow, green antennæ. L. 8 mm. Another mottled white and black L. 10 mm. Another brown white legs two white spots on the sides. One with green eggs L. 9 mm.

A. vaillantii H. Lucas. Bright Red, L. 13 mm. Dredged 10 f. Aug. 17.

A. rubricata Montagu (?) Brownish green, yellow spots on sides Aug. 12, 1915.

Amphithoe sp. Pink, read antennæ, L. 11 mm.

Amphithoe Yellow, pink antennæ. Holdfast. W. A. H.

(Contribution from the Zoological Laboratory of Pomona College)

Annelids from Laguna Beach

This list includes specimens recently determined by Dr. R. V. Chamberlin, but does not include new species reported on at that time.

Glycera rugosa Johnson. *Euphrosyne aurantiaca* John. *Eudistylia polymorpha* Johnson. From holdfast. *Chrysopetalum occidentalis* John.

Diopatra californica Moore. *Podarke pugettensis* Johnson.

Syllis alterniata Moore. *Fionosyllis elongata* Johnson.

Halosydna pulchra Johnson.

H. californica Johnson. Dredged. *Scoloplos sp.* San. Balboa.

Naineris longa Moore? Under stones. *Cirratulus luxuriosus* Moore, all bright red from eel grass. *Polycirrus californicus* Moore.

Nereis agassizi Ehlers. *Anaitides sp. Lumbrineries zonata* John.?

Syllis alternata Moore. *Nepthys caeca* Fabr.?

Sthenelais verruculosa Johnson. W. A. H.

(Contribution from the Zoological Laboratory of Pomona College)

Structure of Dolichoglossus Pusillus

ALMA EVANS

The animals were studied from serial sections cut in several planes. The stains used were carmine, hematoxylin and eosin. The hematoxylin seemed to show the tissues more clearly. A graphic reconstruction was attempted, but did not prove satisfactory because of the individual artificial foldings and contractions. The drawings were obtained by the use of a camera lucida. The general drawings, Figs. 1-9 inclusive, are not filled in in great detail. The special drawings are shown at greater magnification with more of an attempt to show the actual condition.

Dolichoglossus is a soft worm-like animal with ciliated surface. It is divided into three distinct regions: the proboscis, a long club-shaped organ; the collar, a fold in the surface just behind the proboscis, and the trunk, a long cylindrical portion posterior to the collar.

Dolichoglossus is a marine form living in sandy bays or sheltered places. Mucous glands in the surface epithelium secrete a sticky fluid which covers the body and to which tiny sand grains stick. The sand clinging to the mucous coated surface forms a fragile temporary tube in which the animal is usually secluded. The animals in the living condition are bright orange or red but lose their color very soon after preservation in alcohol or formalin.

The proboscis cavity extending the entire length of the organ is surrounded by a network of connective tissue supported by longitudinal bands of plain muscle. This cavity is supposed to communicate with the exterior by a very small opening, the proboscis pore, but this did not show in the specimens examined. The heart, proboscis gland and notochord are located in the posterior part of the proboscis.

The collar contains the central nervous system, part of the notochord, the dorsal blood vessel, ventral and dorsal mesenteries, mouth opening and anterior part of the alimentary canal.

The trunk contains the alimentary canal, dorsal and ventral blood vessels, dorsal and ventral nerves, the gill-slits, the reproductive bodies, dorsal and ventral mesenteries and muscle bands.

The nervous system consists of three parts: the central, located in the collar region, Fig. 5; the sub-epidermic network extending over the entire body just under the surface epithelium, Figs. 1-7; and the dorsal and ventral strands which are thickenings of the sub-epidermic network extending throughout the trunk, Figs. 1 and 7. There is also quite a decided thickening of the sub-epidermic network at the base of the proboscis, Figs. 5, 6.

The vascular system consists of two parts, the central and the peripheral. The central is made up of the heart, a thin-walled vesicle at the base of the proboscis just dorsal to the notochord, and connected with it the proboscis gland, a plexus of capillaries just anterior to the notochord. Fig. 5. The peripheral system is composed of a ventral and a dorsal vessel. The dorsal starts at the heart and continues just ventral of the dorsal nerve throughout the length of the body. Figs. 1, 5, 7. The ventral vessel extends from the posterior border of the collar to the anal end. It is connected with the dorsal vessel by a circular vessel in the posterior edge of the collar.

The mouth is situated ventrally at the base of the proboscis, within the collar,

and opens directly into the straight alimentary canal. The latter is a straight tube extending from the mouth opening to the anus. Figs. 5, 1, 7, 9.

The alimentary canal in the anterior part of the collar gives off a diverticulum, which grows forward and supports the proboscis. Because this diverticulum has the vacuolated appearance of the notochordal tissue of higher animals, it has been regarded as a notochord. It is largest at the base of the proboscis immediately anterior to the heart. Figs. 5, 6.

The paired gill-slits occupy the region just posterior to the collar. They are arranged in two longitudinal grooves in the dorsal wall. The number increases throughout life, new slits appearing just behind those already in place. I found about twenty-five to be the average number, while particular individuals had as low as eighteen and twenty and as high as thirty and thirty-one. The gills are formed in the shape of a U. A skeletal rod or gill bar separates the gills from each other. The gills are supplied with blood from the dorsal vessel. Figs. 3, 7, 8.

The sexes are distinct. The ovaries and testes are saccular organs arranged in a row along the gill and succeeding region. The sacs in other genera, for example Balanoglossus as described by Shipley, open directly on to the epidermis. I have been unable to see these openings in my preparations. Fig. 8 shows the position of the ovaries in the female; the testes in the male are in a similar location.

The surface epithelium is modified ciliated columnar, varying slightly in thickness, size of nuclei and size and shape of cell according to location. Figs. 13, 14, 15.

The epithelium forming the gills and intestine is also modified ciliated columnar. That of the gills having short narrow cells and small nuclei, and that of the intestine having longer thicker cells and large nuclei. Figs. 11, 10.

The connective tissue surrounding the proboscis cavity is of a peculiar arrangement. The connective tissue itself consists of fine strands losely interwoven, but arranged in a definite manner. The strands form a fine network which gives a beautiful lacy appearance. Small round nuclei are quite numerous in connection with the strands. Longitudinal bands of plain muscle are very conspicuous in the connective tissue. These muscle bands are probably used in altering the size and shape of the proboscis. Figs. 4, 20, 21.

The nervous tissue consists of many fibers thickly interwoven. There are a few small nuclei scattered about among the fibers. Figs. 12, 13.

The muscle is unstriated. The fibers are very long in some places, shorter in others and always quite distinct.

(Contribution from the Zoological Laboratory of Pomona College)

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EXPLANATION OF FIGURES

Fig. 1. Cross section through the gill region showing gill opening. D. N., dorsal nerve. D. V., Dorsal vessel. G. O., gill openings. A, alimentary corps. G, gill. V. N., ventral nerve. V. V. ventral vessel. N., nervous tissue. X40.

Fig. 2. Cross section through the base of the proboscis showing diverticulum wall and proboscis gland. D., diverticulum. N., nervous tissue. P. G., proboscis gland. X40.

Fig. 3. Longitudinal section through a gill opening. N,. nervous tissue. G., gill. G. O., gill opening. X40.

Fig. 4. Cross section through the center of the proboscis. N., nervous tissue. M. C., muscle in the connective tissue. T., connective tissue. X90.

Fig. 5. Longitudinal section through the base of the proboscis and collar. M., mouth. C. N., central nervous system. H., heart. No., notochord. P. G., proboscis gland. N., nervous network. A., alimentary canal. D. V., dorsal ventral. X40.

Fig. 6. Cross section through the base of the proboscis showing thickened nerve network. N., nerve network. D., diverticulum wall. H., heart. X40.

Fig. 7. Cross section through gill region. D. N., dorsal nerve. D. B. V., dorsal blood vessel. G. B., gill vessel. V. N., ventral nerve. V. V., ventral vessel. X40.

Fig. 8. Longitudinal section through the gill region. G., gills. B. blood. O., ovary. N., nervous network. X40.

Fig. 9. Cross section of alimentary canal. A., wall of alimentary canal. X40.

Fig. 10. Intestinal epithelium, modified ciliated columnar. X400.

Fig. 11. Epithelium of the gill, modified ciliated columnar. X400.

Fig. 12. Nervous tissue. X400.

Fig. 13. Surface epithelium of proboscis, modified ciliated columnar. X400.

Fig. 14. Surface epithelium of collar, modified ciliated columnar. X400.

Fig. 15. Surface epithelium of trunk, modified ciliated columnar. X400.

Fig. 16. Cells of testis. X400.

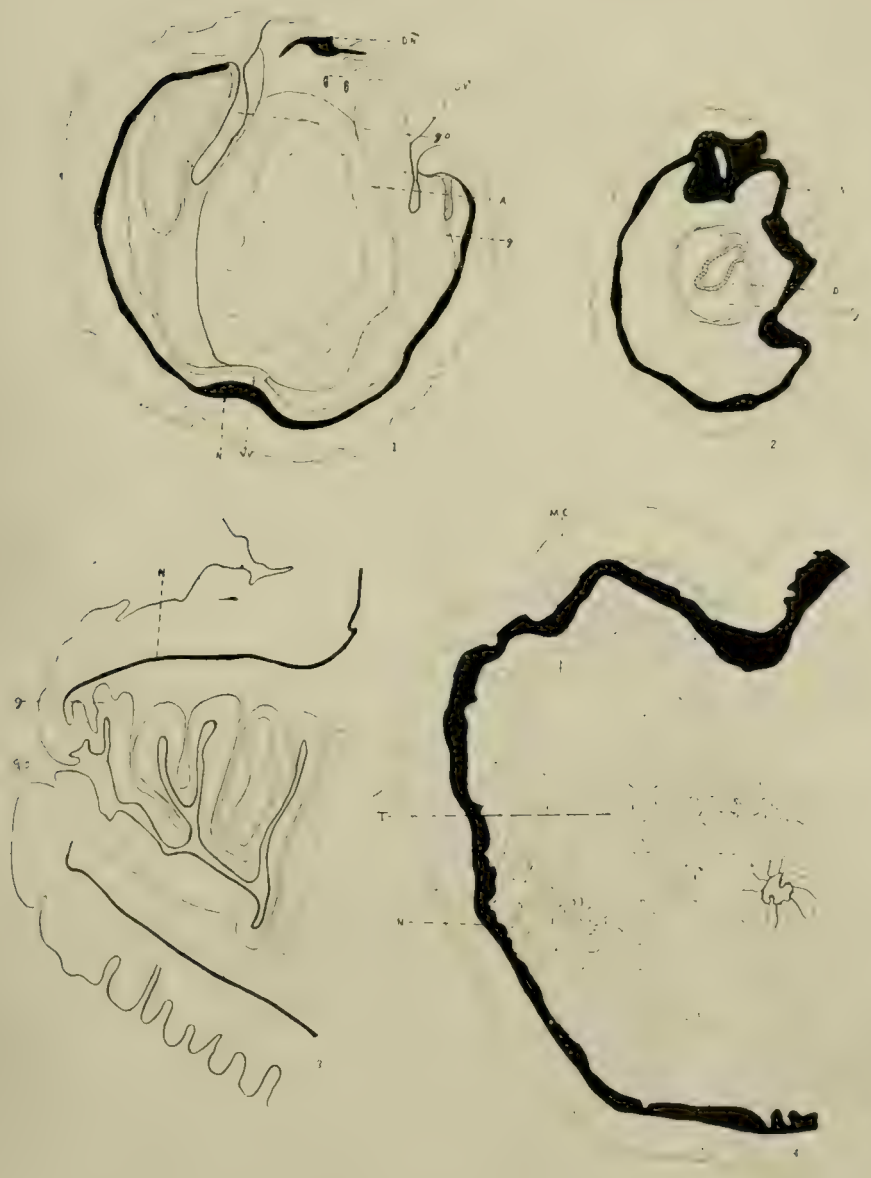
Fig. 17. Ovary. X400.

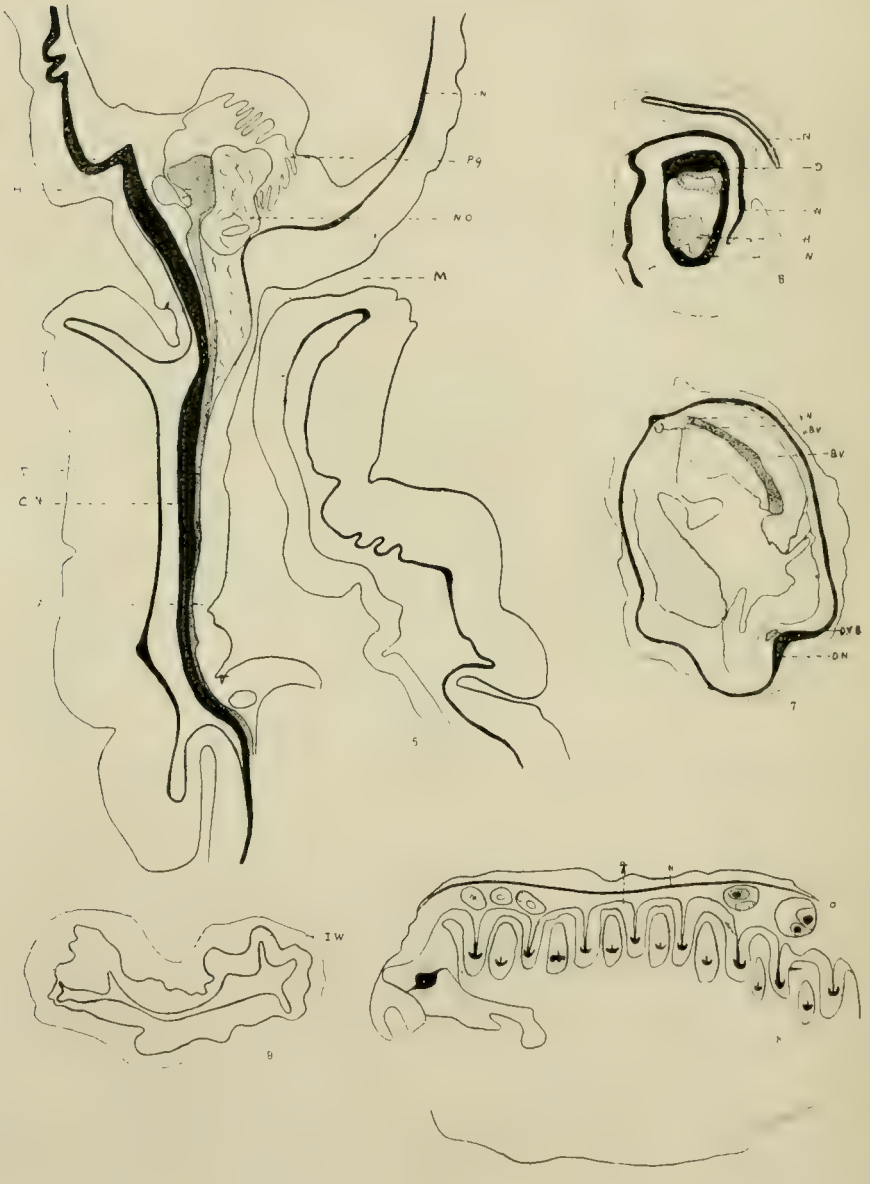
Fig. 18. Plain muscle. X400.

Fig. 19. Epithelium of diverticulum. X400.

Fig. 20. Connective tissue of proboscis. X400.

Fig. 21. Muscle bands in proboscis connective tissue. X400.

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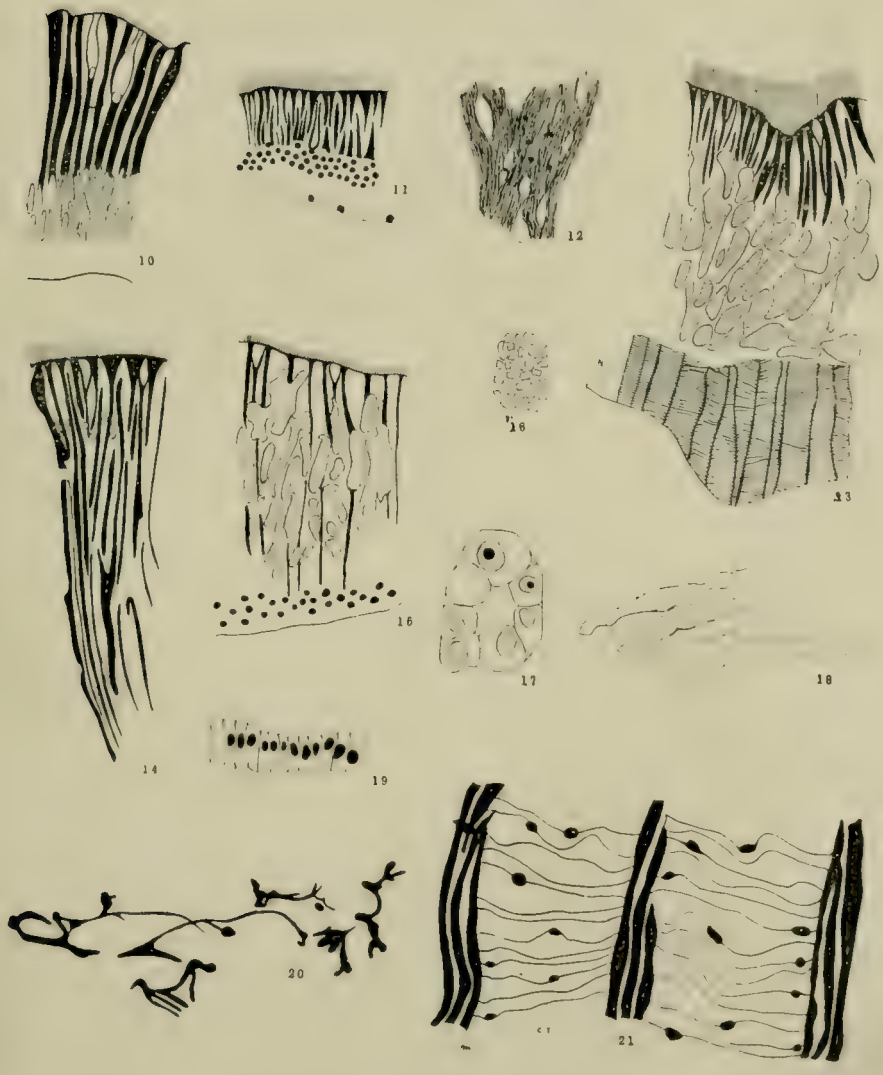
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Opisthobranchs from Laguna Beach

The determinations are by Dr. F. M. MacFarland

TECTIBRANCHS

Pleurobranchæa californica MacF. Only one specimen has been obtained at Laguna Beach, from a depth of from 15 to 20 fathoms. The specimen was mottled dark above and about 5 inches long. Dr. MacFarland informs me that this species is quite common in Monterey Bay and ranges much larger, almost up to 10 inches in length.

Navanax inermis Cooper. Black, yellow lines, blue spots, yellow edges. About two inches in length. Another specimen possibly may be the same species, black with yellow spots. Apparently the same form occurs at Balboa.

Aglaja (Doridium) purpureum Berg.? Brown, dredged 10 to 15 f.

NUDIBRANCHS

Triopha sp. Large, brown. Holdfast.

Flabellina iodinea Cooper. Narrow blue body, red appendages. Swims by lateral movements of the body. This beautiful nudibranch was first found near Laguna by Miss M. Cate, not far from Dana's point in 1916. In Jan. 15, '18, Mrs. May found a number near Laguna Beach.

Dirona picta MacF. Light brown, long thick appendages. Holdfasts and tidepools common in 1915.

Aegires sp. Knobs. Brick red, body clear.

Chromodoris universitatis Cock. Blue, yellow spots.

Polycera atra MacF. Red-brown, black stripes, brown spots. July 10, 1915.

Facelina sp. Body clear, appendages dark.

Ancula pacifica MacF.? Clear white, two yellow lilnes in front, one behind. Front appendages and two lateral tipped with yellow.

Cadlina Sp.? Dark brown, flattened.

Aeolidia sp. White to pink, appendages brown.

W. A. H.

Central Nervous System of the Sand Dollar Dendraster Excentricus Esh

WILLIAM A. HILTON

There seems to be little or no literature on the central nervous system of this form of echinoderm. As might be expected, the general arrangement of radial and circumoral bands are much as in sea-urchins, such as shown especially by Delage and Herouard 1903. There are however some interesting features which make the study of this type of special value.

In this paper only the chief mass of the central nervous system is considered. The more evident parts of the central nervous system are arranged in general as in other forms. The circumoral nerves issue from under the lantern and run along the oral, cross over at the edge of the shell and then run along the aboral side. The five radial nerves converge at the five ocular areas near the center of the aboral region. The circumoral nerve ring is looped over and under parts of the lantern. Fig. 1 shows a part of the lantern and parts of three loops of the circumoral nerve trunk. In the center of the figure one fifth of the lantern is drawn in and from under it a radial nerve is shown in the lower part of the figure. To the left and to the right of the central bony part of the lantern the union of a radial with a circumoral nerve is shown. At the junction of each radial nerve with the circumoral, is a little thickening which seems to be a special cellular mass such as I have not found in other forms. Fig. 7 is a section through a part of a circumoral strand, much enlarged. There are only a few nerve cells, from one to two layers.

As the radial nerves leave the lantern they are quite evident in dissected specimens as they are close to the bony skeleton with very little connective or other tissues to obscure them. The use of aqueous methylene blue aids in following the smaller branches. Near the lantern the branches are small as shown in fig. 2. When the region is reached where the upper and lower surfaces of the shell begin to fuse, the branches become larger and more irregularly arranged, as shown in the lower part of fig. 1 and fig. 2. After the nerve turns to run on the aboral side there is no change in arrangement until the region of the tube feet is reached. In the region of the tube feet the nerves become more numerous, smaller and more regular. The general distribution of the nerves and the arrangement of the tube feet nerves are shown in fig. 4 which is from part of the upper end of the aboral nerve. The holes in the skeleton for the tube feet are shown as circles on each side of the diagram.

The general structure of the chief central nerve trunks is quite similar as shown in sections. Figs. 6, 7 and 8. The nerve trunks have about one to two layers of cells, the main part of the nerves are composed of longitudinal fibers. There are not so many evident vertical fibers from cells as found in starfish and some other forms. This change in position of the fibers may be in part due to the general modification of structure. Whether this arrangement leads to other types of nerve association is a question.

When the nerve trunks are removed, stained in methylene blue and examined with the microscope something of the arrangement of the cells may be seen. In the circumoral and oral radial nerves the nerve cells are thickly massed from side to side, but in the upper part of the aboral nerve there is an evident arrangement of nerve

cells in zones. There is usually a central more or less clear zone, next on each side a rather dense cell area and next on each side a very dense cell area, then a narrow nearly clear zone on each side again.

As a rule slightly larger cells are found near the nerve trunks and as some of these seem to send long branches out into the lateral trunks, they may be motor or sensory, the association neurones are probably the smaller cells in farther. The cells seem multipolar in most cases and in fact much more modified than the cells of starfish or sea-urchin. Figs. 9 and 10.

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(Contribution from the Zoological Laboratory of Pomona College)

Explanation of Figures

Fig. 1. Diagram of one fifth of Aristotle's lantern of *Dendraster* showing three loops of the circumoral nerve ring, and parts of three radial nerves, the central one partly hidden at its origin by the lantern. The nerves are in black. X9.

Fig. 2. Drawing of part of the first part of an oral radial nerve. X9.

Fig. 3. Drawing of the lower end of an oral radial nerve. X9.

Fig. 4. Drawing of the upper part of an aboral radial nerve. The eye spot region is up in the figure. X9.

Fig. 5. Camera lucida drawing of a part of an aboral nerve showing position of cell areas. X70.

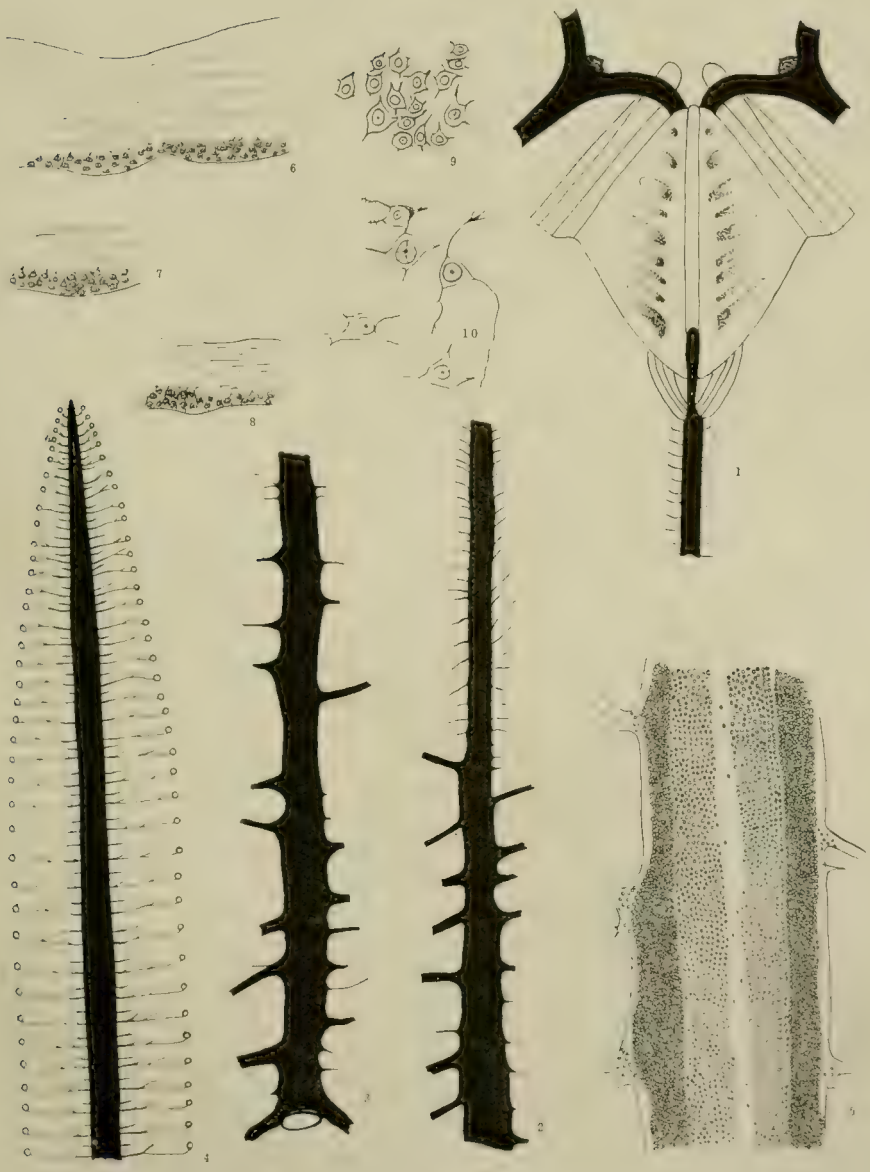
Fig. 6. Drawing of a section of an oral radial nerve. X300.

Fig. 7. Drawing of a section of circumoral nerve. X300.

Fig. 8. Drawing of a section of aboral nerve. X300.

Fig. 9. Nerve cells from central regions of a radial nerve. The arrangement is as shown in the drawing, cells of various levels shown as one layer. Some of the processes possibly relate nearby cells, but most fibers run into the general fibrous mass. All fibers or fibrils are small. There is some indication of tigroid substance in some of the cells. X450.

Fig. 10. Nerve cells from near a lateral branch from the radial band. X450.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Ants from the Claremont Laguna Region

This list includes ants collected chiefly in 1917. All determinations are by Dr. W. M. Wheeler.

Novomessor andrei Mayr. red var. Also some dark. Claremont.
N. pergandei Mayr. Medium, dark colored. Claremont.
Pogonomyrmex californicus Buckley Claremont.
Pheidole longipes Pergande Claremont.
Pediole sp. Claremont.
Crematogaster lineolata Say. Subsp. *californica* Emery. Claremont.
C. l. say. subsp. *corctata* Emery. Claremont.
Solenopsis molesta Say. var. *validiuscula* Emery. Claremont.
S. geminata Fab. var. Claremont.
Liometopum occidentale Emery. Mts. and Claremont.
Iridomyrex pruinosus Roger var. *analis* Ern. André.
I. humilis Mayr (Argentine ant) Claremont.
Dorymyrmex pyramicus Roger *var.* Claremont.
Prenolepis imparis Say. Below Aliso canon, Laguna Beach and Claremont.
Tapinoma sessile Say. Laguna Beach.
Myrmecocystus melliger Forel var. (Honey ant) Claremont.
M. mexicanus Wesm. sub sp. *mojave* Wheeler (Honey ant) Claremont.
Formica rufibarbis Fb. var *occidua* Wheeler. Claremont.
F. cinerea Mayr. subsp. *pilicornis* Emery. Claremont.
Camponotus (Myrmoturba) maculatus Fb. subsp. *vicinus* Mayr. *var. luteangulus* Wheeler. Claremont.

W. A. H.

(Contribution from the Zoological Laboratory of Pomona College)

Isopods From Laguna Beach

The following list is from the collections of 1917. Specimens were determined by the U. S. Nat. Museum. Included in this list are a number of forms which seemed not perfectly typical, so the determinations of several listed before is especially valuable. The names of some of the species have been changed since earlier lists.

Pentidotea resecata Stimp. A number of these were determind by the Museum. Several dredged at 10 fathoms were brown with light markings. Another was uniformly light colored. One found at low tide was a pure brown with darker markings along the sides and center of the dorsum. Another dredged specimen was pure green.

Idothea rectilinea Lock. A very narrow species. Some are almost black mottled with silver. Other specimens are a lighter brown with no silver marks.

I. fewkesi Rich. Large, elongated, yellow-brown, telson pointed.

Paracercis cordata Rich. Brown, dredged 10 fathoms, spines on telson.

P. caudata Say. Coral pink, spines at end of body. Dredged 10 fathoms.

Tanais normani Rich. Small, elongate, among Bryozoa.

There were also in this lot, specimens of a new genus of the family Apseudidæ. These were narrow elongate forms. There was also a new genus and species of the family Anthuridæ. Specimens of this last were pinkish and the caudal end toothed. Neither of the last two species was described at the time this list was sent to the printer. Notes on these will be given later.—W. A. H.

(Contribution from the Zoological Laboratory of Pomona College)

Bryozoa Collected at Laguna Beach in 1918

GENEVIEVE CORWIN

The following list of species includes only those not listed before from this locality.

INCRUSTING

Smittia reticulata Macg. Dredged 10 fathoms.
Microporella californica Busk.

NON-INCRUSTING

Stirparia ciliata Rob.?
Bugula laxa Rob.
Bugula sp.

(Contribution from the Zoological Laboratory of Pomona College)

Phalangids from the Claremont-Laguna Region

The species here listed have been collected during the past two or three years. All determinations but the last two are by Dr. Nathan Banks.

Liobunum exilipes Wood. This is the most common species in the Mts. In the fall great masses of these may be found on vertical rock surfaces.

Protolophus tuberculatus Banks. These are found in the lower altitudes, and not so much in the Mts.

P. singularis Bks. In and about Claremont.

Orthoiasma rugosa Bks. Laguna Beach and Evey Canon 3,000 ft. elevation.

Globipes spinulatus Bks. Claremont.

Leptobrunus californicus Bks. Near Claremont.

Erybrunus brunneus Bks. Claremont. W. A. H.

(Contribution from the Zoological Laboratory of Pomona College)

Isoptera from Claremont-Laguna Region

All specimens were determined by Dr. Nathan Banks.

Reticulitermes tibialis Bks. Medium sized. Collected at Claremont. Winged forms were found in front of Science Hall Nov. 12, '17. They were also found in other parts of the region.

Reticulitermes Sp. From near Claremont and from Middle Ranch, Catalina Island.

R. hesperus Bks. Small dark colored winged forms collected in Holmes Hall, May, 1913. Also some soldiers and workers from Evey canon, Nov. 8, 1917. Also from the interior of Catalina Island.

Termopsis augusticollis Hag. Large specimens. Palmer's canon, 1918.—W. A. H.

(Contribution from the Zoological Laboratory of Pomona College)

Diplopods from the Claremont-Laguna Region

The determinations were made by Dr. R. V. Chamberlin.

Parajulus furcifer Hag. Small species collected by Ivan Johnson altitude 5,200 ft. San Antonio canon. Dec. 21, '17. Also from Red Hill near Upland.

Atopetholus parvus Chamb. From near Claremont.

A. californicus Chamb. From near Claremont.

Tylobolus claremontus Chamb. Large species from Claremont and Mts. near.

W. A. H.

(Contribution from the Zoological Laboratory of Pomona College)

Notes on Serpent Stars from Laguna Beach

During the summer of 1918, all species were found that had been previously reported from this locality, largely by Miss Wortha Merritt.

From the Balboa mud flats the long-armed serpent stars *Amphiodia barbarae*, were taken again. This and one other species were the only ones sent to Dr. H. L. Clark for determination.

For a number of years we have been finding serpent stars of medium size with dark brown markings. These were at first confused with others but, as they seemed different from all others reported, one was sent to Dr. Clark for determination. They were determined by him as follows:

"*Ophiopteris papillosa*, a relatively rare ophiuran. . . . The genus is peculiar for its flat, nearly circular upper arm spines. It is most desirable to know if there is anything in the habits or habitat to account for this—"

This species seemed not uncommon in the littoral zone at Laguna Beach. A few were obtained from kelp holdfasts from deep water, but last summer Miss Merritt found them especially abundant in rocky tidepools containing many sea-urchins. The serpent stars were around and under the sea-urchins.—W. A. H.

(Contribution from the Zoological Laboratory of Pomona College)

Smaller Shells Collected at Laguna Beach During the Summer of 1917

EVA MAY HYDE

The shells illustrated are all small specimens. Nearly all were determined by Mrs. T. S. Oldroyd. All drawings are three times the natural size unless otherwise stated. S is for shore collection under stones, D for shells dredged about 10 fathoms just off shore. When colors are evident some indication is given in the list. Many are young.

1. *Turbonilla jewetti* D. and B. Shore.
2. *T. tenuicula* Gld. S. Old Det.
3. *T. buttoni* D. and B. S. Old Det.
4. *T. tenuicula subcuspidata* Cpr.? Dredged. Old. Det.
5. *T. laminata* Cpd.? D. Old. Det.
6. *Cerithiopsis pedroana* Bart. S. Det. Old.
7. *Seila assimilata* Cpr. S. White. Det. Old.
8. *Metaxia diadema* Bartsch D. Old. Det.
9. *Eulima (Melanella) rutila* Cpr.? D. Glossy white.
10. *Bittium quadrifilatum* Cpr.? (Young) D. Old. Det.
11. *Rissoina kelseyi* Bartsch D. White. Old. Det.
12. *Cæcum crebricinctum* Cpr. D. Light brown. Det. Old.
13. *Cæcum californicum* Dall. S. and D. White. Det. Old.
14. *Columbella carinata* Hds. Immature. D. Light.
15. *C. turberosa* Cpr. D.
16. *C. gausapta* Gld. S. Brown. Old. Det.
17. *Alectrion mendica* Gld.? D. Old. Det.
18. *A. fossata* Gld.? D. White.
19. *Amphissa corrugata* Rve. (Young) S. Old. Det.
20. *A. versicolor* Dall D. Juv. Old. Det.
21. *Lacuna unifasciata* Cpr. S. Tan striped with brown. Old.
22. *Astyris gansipata* Gld. S. Tan and brown.
23. *Anachis penicellata* Cpr. S. Det. Old.
24. *Thais emarginata* Desh. S. Young. Tan and brown. Det. Old.
25. *Cerithidea californica* Held. ½ Natural size (Young). S. Balboa. Gray. Old.
26. *Arcularia (Nassa) tegula* Rre. Young ½ Natural size, Balboa. S. Gray. Old. Det.
27. *Saxicava arctica* Linn. Young ½ Natural size. S. Dirty white. Twisted shell. Old.
28. *Dialia acuta* Cpr. D. White. Old. Det.
29. *Eulithidium substriatum* Cpr. S. Dark pink. Old. Det.
30. *Phasianella pulloides* Cpr. S. Tan. Old. Det.
31. *Odostomia fatella* Bartsch. S. Old. Det.
32. *Tritonalia* Sp. (very young) White.
33. *Melanella thersites* Cpr. White D.
34. *Marginella pyriformis* Err. D. Dirty white, polished. Old. Det.
35. *Liotia fenestrata* Cpr. S. White. Old.
36. *Leptothyra carpenteri* Pils. Tan. Old.
37. *Tritonalia interfossa* Cpr.? S. Old. Det.
38. *Acmæa* sp. D. White.
39. *Margarites acuticostatus* Cpr. D.
40. *Tegula viridulum ligulatum* Mke. Very young. D. Old. Det.
41. *Hipponyx* Sp. D.
42. *Philobrya setosa* Cpr. S. White.
43. *Marginella varia* Sby. S. Glossy.
44. *Cardita subquadrata* Cpr. S. White. Old.
45. *Littorina scutulata* Gld. S. Brown.
46. *Tornatina cerealis* Gld. White.

47. *Erato columbella* Mke D. White.
48. *Paphia tenerrima* Cpr. Juv. Old. Det.
49. *Calliostoma annulatum* Mast. D. Det. Old.
50. *Olivella pedroana* Conr. ½ Nat. size. S.
51. *Septifer bifurcatus* Rve. Young.
52. *Mytilus californianus.* Conr. Young.
53. *Dentalium semistriatum* Br. and Sby. D. White.
54. *D. neohexagonum* S. and P. White.
55. *Macron lividus.* A. Ad. (young) Brown. Shore.
56. *Epitonium hindsii* Cpr. S. White. Often found on sea anemones. *E. crenatoides* Cpr. was found in similar locations.

Nucula castrensis Hinds. At low tide common under stones.
Malletia faba Dall. These were dredged or found in holdfasts.
Lima dehiscens Conr. These were found in holdfasts of kelp.
Botula (Adula) falcata Gld. This elongate rock borer was found but not so commonly as the other similar species.
Leptothyra paucicostata Dall. S. Old. Det.
Columbella tuberosa Cpr. Old. Det.
Marginella pyriformis Cpr.

(Contribution from the Zoological Laboratory of Pomona College)


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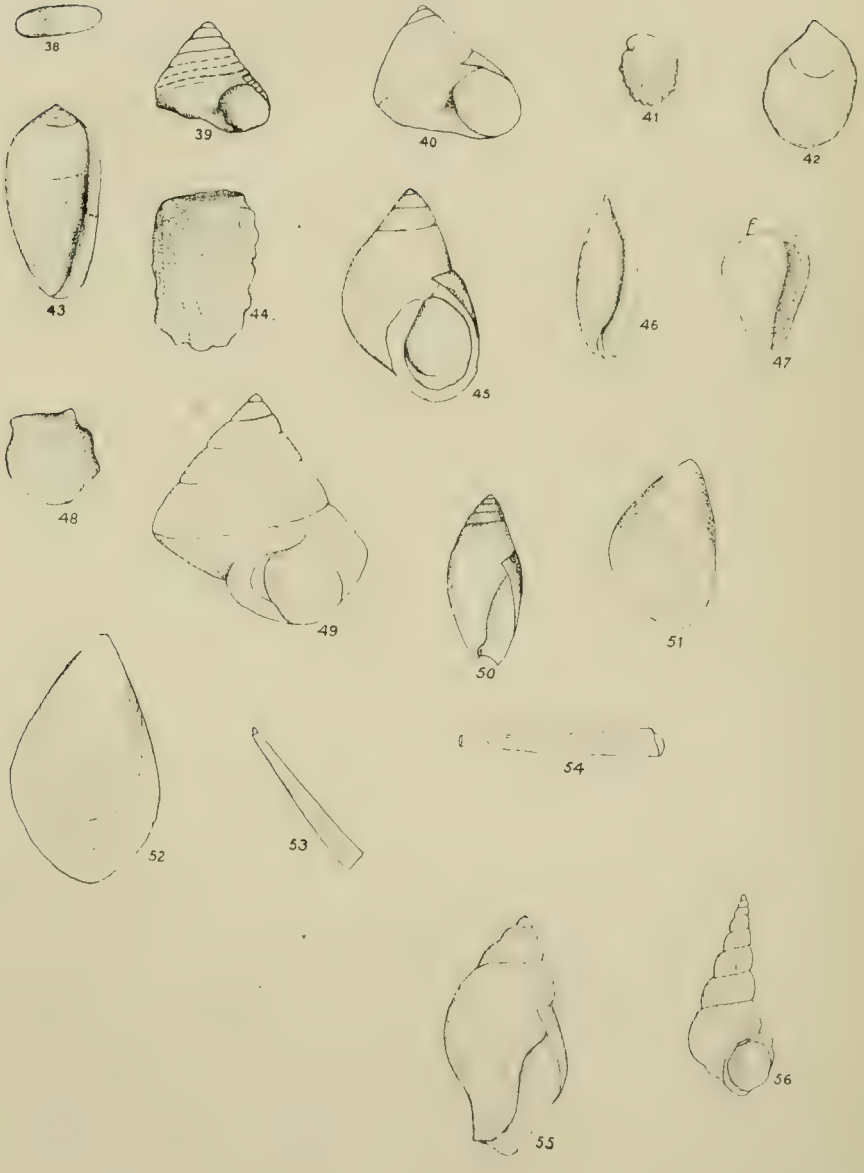
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Notes of the Ancestry of the Coleoptera*

BY G. C. CRAMPTON, PH. D.

There are three principal theories concerning the probable nature of the ancestors of the Coleoptera. In one of these, it is maintained that they were like Neuroptera, in another it is maintained that they were like Blattids, and in a third, it is maintained that they were like Dermaptera.

The chief reason for assigning the Coleoptera a position near the Neuroptera is that both groups exhibit a complete metamorphosis, and since the Neuropters are considered to be the most primitive of insects with complete metamorphosis, they are regarded by many as the nearest living representatives of the ancestors of holometabolous insects, including the Coleoptera. The nature of the metamorphosis exhibited by the two groups, however, is not adequate evidence for placing them near together, unless a study of the comparative anatomy of the two orders would bear out such an assumption, since a complete metamorphosis occurs in some Hemipteroid insects (Coccidæ) and not in others, and its presence or absence is therefore not sufficient proof of relationship unless supported by the evidence of comparative morphology as well. If both Neuroptera and Coleoptera are ultimately to be traced back to Plecoptera-like forbears (as seems to be the case) it is possible to maintain that tendencies present in the Plecopteroid stock (such as the rather marked difference between the nymphal and adult forms apparent in certain Plecoptera) could reappear and find opportunity for greater development in two distinct lines of descent ultimately derived from such a common stock, if both were subjected to similar environmental or selectional influences. The similarity between larval Coleoptera and Neuroptera in the nature of their thoracic sclerites and other structures has been referred to in an article recently published in the Proceedings of the Entomological Society of Washington; but, as I there stated, other structural similarities between the Coleoptera and the members of the group to which the Dermaptera belong would greatly outweigh the above mentioned resemblances between the Coleoptera and Neuroptera.

Some of the lower Coleoptera such as the Lampyridæ, etc., have broad pronota and flattened bodies bearing a superficial resemblance to certain Blattids; and, since there is a marked tendency toward a thickening of the fore wings to form tegmina in the latter group, this is taken as evidence of the ancestral nature of the Blattids by certain investigators who would seek to derive the Coleoptera from Blattoid ancestors. On the other hand, a comparison of the anatomical structures of the Coleoptera with those of the members of the group next to be considered (the Panplecoptera), has brought to light similarities so much more profound and far reaching (even with regard to the minuter details) that I have become convinced that the closest affinities of the Coleoptera are with the members of the group in question, and that the Dermapteron representatives of this group approach extremely closely to the Coleoptera in their lines of devlopmnt. The Dermaptera alone, however, have by no means retained all of the ancestral features present in the forebears of the Coleoptera,

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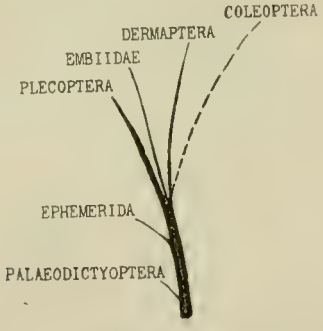
*Contribution from the Entomological Laboratory of the Massachusetts Agricultural College, Amherst, Mass.

having developed many specializations of their own and having lost many ancestral features in the process, but they appear to have departed as little as any known forms from the probable ancestral condition of the Coleoptera; and certain other members of the group to which the Dermaptera belong have retained some of the ancestral features which the Dermapters have lost, so that it is necessary to make a study of the composite characters of the group as a whole in attempting to determine what the ancestors of the Coleoptera were probably like.

Before taking up the discussion of the relationship of the Coleoptera to the other members of the group "Panplecoptera," it is necessary first to point out the interrelationships of the insects comprising this group, and the appended diagram is given in order to make these relationships more readily apparent. The primitive fossil Palæodictyoptera are doubtless very like the ancestors of winged insects in general, and some of them are quite closely related to certain members of the group Panplecoptera. The Ephemerida are among the most primitive living representatives of the forms which branched off very near the base of the Panplecopteron line of development, but the Plecoptera are the most important of the insects actually composing the group, having retained more of the characters occurring in the common ancestral forms which gave rise to the different lines of descent of the insects composing the group, and their line of descent is therefore made much heavier in the diagram, to emphasize their importance as the nearest living representatives of the ancestors of the rest of the insects in the group.



The nearest relatives of the Plecoptera are the Embiidæ (*Sensu lato*) whose line of development parallels that of the Plecoptera remarkably closely—in other words, the two groups have retained many features in common. The Dermaptera (Euplexoptera), among which are included the Hemimeridæ, have rather more features in common with the Embiidæ than with the Plecoptera, but the Plecoptera also exhibit many features which are retained by the Dermaptera, and I am inclined to regard the Plecoptera, rather than the Embiidæ, as the nearest living representatives of the ancestral forms which gave rise to the Dermapteron line of descent. As I have pointed out in a paper on the thoracic sclerites of immature winged insects (Proc. Ent. Soc. Washington, 1918) the thoracic sclerites of the Dermapteron *Arixenia* are remarkably like those of certain immature Plecoptera as is also true of the head region, the nature of the cerci (of immature Dermaptera such as *Diplatys*, etc.), and many other features which need not be enumerated here, since I propose to take them up in another paper dealing with the ancestry of the Dermaptera, etc.

As was stated above, the Dermaptera have many features in common with the Embiidæ and Plecoptera, and similarly, the Coleoptera (whose line of development appears to parallel that of the Dermaptera quite closely) have also retained certain features which occur in the Embiidæ and Plecoptera. Since the Coleopteron line of development parallels that of the Dermaptera quite closely, and since the Dermaptera have rather more in common with the Embiids than with the Plecoptera, the Coleoptera also are rather more like the Embiids than they are like the Plecoptera, as might be expected. Bearing these facts in mind, and taking the composite features of the superorder Panplecoptera as a whole, for comparison with the composite characters of the Coleoptera as a whole (since some members of a group will retain certain primitive features which other members do not retain), I would point out the following similarities between the Coleoptera and the other members of the superorder Panplecoptera, which, to my mind, indicate that the ancestors of the Coleoptera were like certain insects belonging to this superorder rather than to any other

Both the Coleoptera genuina and the Dermaptera are typically prognathous (mouth parts directed forward) as is true of most of the insects belonging to the superorder Panplecoptera. The segments of the antennæ in certain Coleoptera, such as the Cerambycids, etc., are very like those of certain Dermaptera. The nature of the maxillæ with its peculiar subdivisions in these two groups is markedly similar in both Coleoptera and Dermaptera. The character of the labium of the Coleopteras, on the other hand, is more like that of the Embiids, in which there is a tendency toward the union of the under lip with the head capsule and a demarking of a longitudinal gular region on the under surface of the head. There is a well-defined tendency toward a thickening of the fore wings in some Plecoptera, and in certain of them the fore wings become greatly shortened, and but few veins (mostly the longitudinal ones) are retained in some cases. In the Embiids, the tendency toward the retention of the longitudinal parallel venation is even more marked; but the thickening of the wings is not so pronounced, although traces of it are to be found even among the Embiids. The thickening of the fore wings to form elytra is very marked in the Dermaptera, in which they are extremely like the elytra of certain Coleoptera. Some of the flattened Dermaptera such as *Hemimerus* have broader pronota resembling the pronota of certain Lampyrids, while other Dermaptera have narrower pronota like those of other Lampyrids. The neck plates of the Coleoptera are more like those of the Embiids, but the prothoracic sclerites of the Coleoptera are more like those of certain Dermaptera, in which the trochantinus intervenes between the bases of the coxa and the pleural region which tends to unite with the pronotum in both groups. The legs of the Coleoptera could readily be derived from the Dermaptetron type, except that the tarsi of the Dermaptera, like most of the other primitive members of the Panplecopteron group, are trimerous. The posterior coxæ of the Coleoptera are more like those of the Embiids than those of the Dermaptera, and the general plan of the meso- and metathoracic sclerites (with the exception of the tergal region) is somewhat more alike in the Embiids and Coleoptera, although the mesonotal and metanotal regions of the Coleoptera and Dermaptera are astonishingly similar even to the minutest details, as was pointed out in a paper dealing with this subject in Vol. 25 of Psyche (p. 4). The abdnominal paranota (lateral projections of the tergal region) of certain Lampyrids and other Coleoptera are also present in such Dermaptera as *Ancistrogaster luctuosus* Stal. It may be remarked in passing, that the paranota are very ancient structures occurring in Palæodictyoptera, certain primitive Ephemerida (nymphs

and adults) and other lowly organized insects, and their retention in the Coleoptera must therefore be regarded as a very primitive feature. As I have pointed out in several papers, the cerci of such larval Coleoptera as *Galerita janus* Fab., are remarkably similar to those of such nymphal Dermaptera as *Diplatys severa* and *Karschiella* even in regard to such minute details as the relative size of the individual segments, etc.; and the paraprocts (lateral plates near anal opening) and genitalia of the Coleoptera could readily be derived from the Dermapteron type.

It has been argued that such Coleoptera as the Staphylinidæ, which have retained a body-form strongly resembling that of certain Dermaptera, are highly specialized in many respects. This however has no bearing on the structural resemblance of certain Lampyroid Coleoptera (which are very primitive in their general makeup) to certain Dermapters, and it by no means disproves the contention that the Staphylinidæ have retained a primitive body form, despite the presence in some of them of rather highly specialized characters. Every student of evolution and comparative anatomy knows full well that animals which are very primitive in some respects may have developed certain other characters to a rather high degree of specialization, and on this account, we have to take the *composite* primitive characters (gleaned from many sources) of a group in order to arrive at a correct conclusion concerning the nature of the forms ancestral to that group; and what may be termed the "forerunners" of these composite primitive characters are to be sought among the more primitive representatives of the superorder of which the group in question is a member. On this account, we must examine not only the Dermaptera, but also the Embiids and Plecoptera in order to ascertain the probable origin of the ancestral features found in the Coleoptera, although some one group, such as the Dermaptera, would naturally be expected to retain more of these ancestral features than the others have done.

It must be borne in mind that both the Psocidæ (*sensu lato*) and the Neuroptera were probably descended from Plecoptera-life forebears, and therefore it is merely to be expected that similar characters would be carried over into both the Dermaptero-Coleopteron lines of descent and the Psocid-Neuropteron lines of descent. The characters which they all have in common would therefore be inherited from their common ancestral stock (related to the Plecoptera), and would merely indicate that Coleoptera, Psocidæ and Neuroptera are to be traced back to more primitive common ancestors (resembling Plecoptera) rather than that Coleoptera are descended from the rather highly developed Psocidæ, or even from the Neuroptera. Furthermore, the Blattidæ, Grylloblattidæ and their relatives, are very probably ultimately descended from forms not unlike the ancestors of the Plecoptera, and since they have remained very primitive in many respects, it is not surprising that they too exhibit certain features suggesting a condition ancestral to the Coleoptera and Dermaptera; but the closest affinities of the Dermaptera are with the Embiids and Plecoptera, and the closest affinities of the Coleoptera are with the Dermaptera and their allies, so that we are justified in assuming that the nearest living representative of the immediate ancestors of the Coleoptera are the Dermaptera, which are more primitive structurally than the Coleoptera, and have therefore departed less than they from the ancestral condition.

It has been argued that the known fossil remains of the Dermaptera are not as old geologically, as the first Coleoptera to appear, and on this account the Coleoptera cannot be derived from Dermaptera-like forebears. In this connection, however, I would simply call to mind the fact that formerly it was contended that the anatom-

ically more primitive Coleoptera genuina could not represent the ancestral condition of the group since the fossil remains of the more highly specialized Rhynchophora antedated them geologically. Later, however, discoveries of earlier Coleoptera genuina completely vindicated comparative anatomy, and showed that the lack of known remains of earlier Coleoptera genuina was merely due to the incompleteness of the palæontological record—and I cannot help feeling that the same will hold true in the case of the Dermaptera. The Dermaptera are not nearly as numerous as the Coleoptera, and, since the preservation of fossil remains is so largely a matter of chance (as is their discovery also), it is merely to be expected that fewer Dermaptera than Coleoptera will be discovered, and their apparent absence in the older strata will doubtless prove to be simply a case of incompleteness of our record, rather than a case of their not occurring in a period contemporaneous with, or antecedent to, the appearance of the Coleoptera upon the scene.

In Psyche, Vol. 25, page 4, it was stated that the Coleoptera should be included in the superorder Panplecoptera, and that the Strepsiptera might possibly be included with them also. I have recently examined some Strepsipteron material, however, which would indicate that the closest affinities of the Strepsiptera are with the Hemipteroid insects and other forms descended from Psocid-like or Neuroptera-like forebears; so that until more details of Strepsipteron anatomy, and the range of variation in the group, are known it is preferable to reserve opinion in the matter of their closest affinities, until all of the available evidence on the subject is forthcoming.

As to the relationships of the other orders of living winged insects, they might be grouped into five main superorders as follows: the *Panneuroptera,* comprising the Siphonaptera and Diptera, the Mecoptera, Neuroptera, Hymenoptera, Trichoptera and Lepidoptera with their allies; the *Panhomoptera* comprising the Psocidæ, Mallophaga, Thysanoptera, Anopleura, Hemiptera and Homoptera with their allies; the *Panplecoptera* including the Coleoptera, Dermaptera, Embiidæ, Plecoptera and their relatives; the *Panorthoptera,* comprising the "Locustidæ," Gryllidæ, "Acrididæ," Tridactylidæ, Phasmids, Grylloblattids and their relatives; and the *Panisoptera,* comprising the Blattidæ, Mantidæ, Zoraptera and Isoptera, with their immediate relatives. The Odonata and Ephemerida were formerly grouped in a sixth superorder, the *Panplectoptera,* but they have not a great deal in common, and there is some question in my mind whether the Ephemerida should be placed here, or with the Plecopteron group, with which they also have certain features in common. The Ephemerida likewise resemble certain fossil Palæodictyoptera in many respects, and it is also possible that these should be grouped together; but until more is known concerning the anatomical details of these fossil forms, it is impossible to place them correctly, since the study of the wing venation, or any one set of structures, is entirely inadequqate evidence upon which to base one's conclusions.

There are a few orders of insects which are extremely difficult to place definitely. Thus, the Tenthredinoid Hymenoptera have a surprisingly large number of features in common with the Mecoptera (e.g. male genitalia, thoracic sclerites, head and mouth parts, etc.) and it is very probable that they should be grouped in the same super order with the Mecoptera; but these Hymenoptera likewise exhibit a number of features in common with the Psocidæ, thus making it extremely difficult to determine their exact affinities. The other order of living winged insects not accounted for is the Strepsiptera, and these are even more difficult to place. They have much in common with the insects descended from Psocid-like forebears, and might possibly be

included in the superorder containing these forms. On the other hand there is much that is suggestive of Coleopteron affinities in the Strepsiptera, and until more is known of their anatomy and development, it is preferable to suspend judgment in the matter of determining their closest affinities until the necessary evidence is forthcoming.

Of the fossil insects, so little is known concerning the details of their anatomy, that it is futile to attempt to determine which superorders they should be grouped with (or whether they belong in new superorders) until more is known concerning them than the bare details of their wing venation. It may be mentioned in passing, however, that the so-called Protorthopetra should doubtless be grouped in the superorder Panorthoptera. The Protoblattoidea resemble certain members of the Panplecoptera in some respects, and if their closest affinities are with the Blattids as most palæontologists maintain, they may serve to connect the Blattid-group with the Panplecoptera. Such Palæodictyoptera as *Stenodictya* have cerci like those of the Plecoptera, and the abdominal paranota of *Stenodictya* are very like those of certain members of the Panplecoptera such as the Lampyrids, Dermaptera (*Ancistrogaster*) etc. The wings of Stenodictyia are quite comparable to those of certain Plecoptera, and its head could be readily referred to the Plecopteron type in certain features. The tarsi too seem to be trimerous in *Stenodictya* as in the more primitive representatives of the group Panplecoptera. On the other hand, *Stenodictyia* exhibits a great many characters suggestive of affinities with the Ephemerida, and the determination of the closest affinities of those fossil forms must await the further study of their anatomical details which can be more satisfactorily carried out when better preserved specimens than the present-known fragments are available for examination.

General Structure of Phoronis Pacifica Torrey

RUTH LEDIG

Phoronis lives in tubes formed by particles of sand and small pebbles which are held together very firmly by a secretion from the body. These tubes are entirely separate from each other. In preserving the animals for sections the tubes were usually removed from the animals before fixation. The usual picric or mercuric fixing reagents seemed to give good results. After sectioning or before, a carmine or hematoxylin stain was used; the latter gave the best results, followed with eosin. The animals are so small and delicate that it was necessary to study their anatomy by means of serial sections.

In Phoronis the buccal and anal openings are both in the anterior end of the animal. The head end has two lopophore organs bearing numerous tentacles arranged spirally. The digestive tract is U shaped. This species varies in length, based on the material at hand it is from one to two and one-half inches in length.

The vascular system consists of a circular ring of the blood vessel about the esophagus. From this ring vessels run into each tentacle and one vessel follows and is parallel with the digestive tract. Opposite to this vessel is one returning the blood to the circumesophageal ring.

The nervous system consists of a ganglion between the anal and the mouth opening, It is made of modified surface cells. From this ganglion a circle of nervous tissue extends about the esophagus and from this a single unsymmetrical nerve or sense organ runs the length of the body in the epithelium of the body wall.

Two nephridia are found, each of which is situated near the surface equally distant from the anal opening.

Phoronis pacifica has both testis and ovary in the same individual.

Further details of structure are shown in the figures.

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(Contribution from the Zoological Laboratory of Pomona College)

EXPLANATION OF FIGURES

Fig. 1. Cross section of the lopophore organs of *Phoronis pacifica* showing sections of tentacles. X 70.

(a) Each tentacle is made up of a circular band of muscle within which is found a small blood vessel.

Fig. 2. Cross section of base of lopophore organ of *Phoronis,* showing the beginning of the buccal cavity, the anal opening and the bases of the tentacles. X 70.

Fig. 3. Cross section of the anterior end of *Phoronis.* X70.

(a) Digestive tract., (b) blood, (c) nerve ganglion, (d) nephridia, (e) anal end of intestine, (f) base of tentacles.

Fig. 4. Cross section through the upper end of the body of Phoronis. X 70.

(a) esophagus, (b) blood, (c) dorsal blood vessel, (d) intestine, (e) nephridia, (f) epithelium of body cavity.

Fig. 5. Section of the body of *Phoronis* farther back. X70.

(a) stomach, (b) blood, (c) mesentery, (d) nerve, (e) intestine, (f) epithelium, (g) longitudinal muscles of body wall.

Fig. 6. Section through the body of *Phoronis* near the end of the body. X70.

(a) gonads, (b) stomach, (c) intestine, (d) mesentery, (e) epithelium, (f) longitudinal muscle of body wall, (g) circular muscle of body wall, (h) longitudinal nerve?

Fig. 7. Section of body wall. X300.

(a) epithelium of surface, (b) circular muscle, (c) longitudinal muscle.

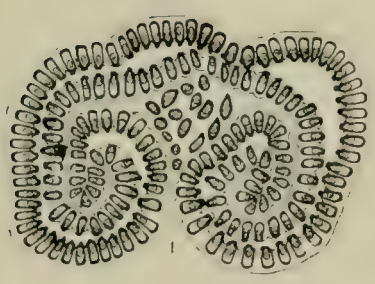
Fig. 8. Section base of tentacles. X300.

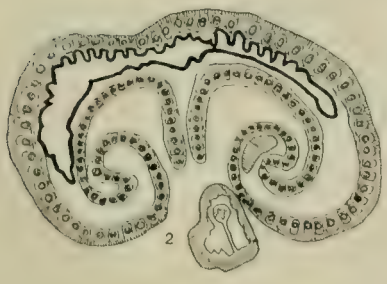
(a) epithelium, (b) muscle, (c) blood.

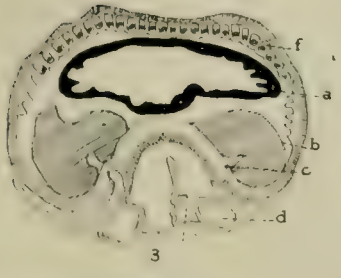
Fig. 9. Section of ganglion of *Phoronis.* X300.

Fig. 10. Blood corpuscles massed together. X300.

Fig. 11. Section of ciliated epithelium of digestive tract. X300.





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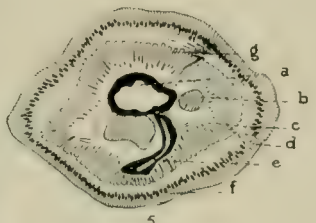
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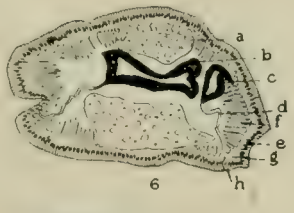
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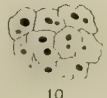

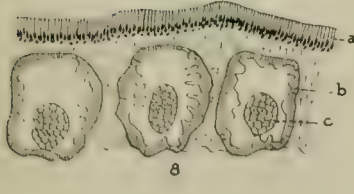
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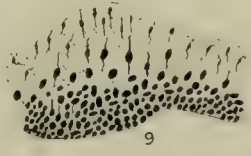

Acarina from Claremont-Laguna Region

The present list is from specimens collected during the past years. The determinations are by Dr. Nathan Banks.

Dermanyssus gallinae Redi. From chickens, some from other situation.

Parasitus frontalis Bks. From wild mouse. Laguna Beach.

Parasitus sp. Not mature. Free living, Claremont.

Parasitus sp. Free living, not mature. Chino Swamps.

Anystis agilis Bks. Claremont, on ground. Abundant in March, 1918, and also in other years. Small red.

Trombidium pacificum Bks. Medium sized dark red, from ant's nest also from Evey canon.

T. claremonti Bks. Evey canon.

T. magnificum Leconte Mts. near Claremont, 8,000 ft. elevation. Large dark red mite. Johnston Col.

Trombidium sp. Near Camp Baldy, 4,500 ft. elevation. . Johnston Col.

Bdella pergrina Bks. Claremont, Calif. Common. Also Chino Swamps.

Penthaleus bicolor Bks. Spherical, dark body, red legs. Common Claremont in spring.

Tarsotomus terminalis Bks. Small mites. Head of San Dimas canon.

Erythæus hiltoni Bks. Claremont.

Erythæus sp. not mature. Claremont.

Macrocheles sp. Chino Swamp.

TICKS

Argas miniatus Koch. Large ticks, exact location of capture unknown.

Dermacentor occidentalis Neum. Mts. near Claremont. Pudding stone canon, Evey's canon.

Hæmaphysalis leporis palustris Pack. On rabbit, Claremont.

Ixodes californicus Bks. Laguna Beach. Also on dog, Claremont. W. A. H.

(*Contribution from the Zoological Laboratory of Pomona College*)

The Central Nervous System of Dolichoglossus

WILLIAM A. HILTON

Specimens were fixed in the living condition in mercuric chloride or other strong reagents and cut in series. Hematozylin stains seemed best for details.

A study of the nervous system of this animal suggests similar structures in echinoderms. The surface epithelium is in many places underlaid with nerve strands. In some places these nerve fibers are very thick, in others only a few strands are evident. The epithlium of the surfaces of the proboscis, collar and body is of varying thickness and ciliated. Among the columnar cells there are in places numbers of modified mucous secreting cells or goblet cells. In some places also there are specialized nerve or sense cells which are modified epithelial cells whose processes are slender and run as nerve fibers below the layer of nuclei. Multipolar cells also occur.

We may speak of the nervous system as being the lower fibrous layer of the epithelium in many parts of the body. This central nervous system is especially thickened on the dorsal side of the body, particularly at the junction of the proboscis and collar and also under the collar on the dorsal side. The part which might be called the brain is the band of nervous tissue which separates itself from the surface of the collar on the dorsal side yet retains a large number of cells and a thick band of fibers. This dorsal nervous system is connected with a longitudinal thickening on the dorsal side of the animal below the collar, but it is only slightly connected with the poorly developed sub-epithelial thickening on the dorsal side of the collar. There is very little indication of a ventral nerve cord in the region of the collar.

The nervous system under the epithelium of the proboscis has nerve fibers under it in about the same degree of thickness at all points. Local variations of thickness are probably due to special contractions at the time the specimen was killed.

In all parts but the dorsal region of the collar the nervous system is intimately associated with surface epithelium. At the region of the collar the dorsal strand is made up of some cells and many longitudinal fibers. Below the collar the dorsal nerve band continues to be definitely marked from other parts of the epithelium and looks much like the nerve trunk of the starfish. The same is true in less degree of the smaller ventral nerve trunk which is seen below the collar.

The nerve cells seem to be of two sorts. First those which may in part be sensory, bipolar cells reaching from near the surface down into the fibrous band. These cells usually fork at the inner surface of the fiber layer and give off minute branches as they pass through the fiber area. Second, multipolar cells whose bodies are located in the deeper layers of the nuclei with one or more branches which run into the fibrous area.

The general appearance of a band of nerve fibers under the nuclear layers is a mass of fine branches with many cross lines and very many finer longitudinal strands which cannot be followed very far as individuals. The cross lines are those fibers which in some cases can be seen to be continuations of the cells of the epithelium. The fine longitudinal lines are in large part the small lateral branches of the cross fibers just mentioned. There is quite a dense network of fibers in all parts of the fibrous

nervous system. In detail the structures are quite different from those of echinoderms where the strands from cells in most cases seem to be almost the only processes in the fiber areas. In Dolichoglossus there are not such long slanting fibers from single cells as in echinoderms and conduction seems possible chiefly through the small and apparently short lateral branches of the long nerve cells. Possibly the branched inner ends of the cells furnish some means of conduction. These last resemble similar structures in certain echinoderms. The fine lateral branches and the absence of crossing lateral fibers seems to show a slightly more advanced type of structure than we find in the starfish group. In the central part of the nervous system, that is the dorsal nerve of the collar, longitudinal fibers are more evident than in other parts.

No distinction between fiber and fibril could be seen. The larger strands did not seem to be made up of smaller ones and the smaller ones seemed to be processes of larger ones.

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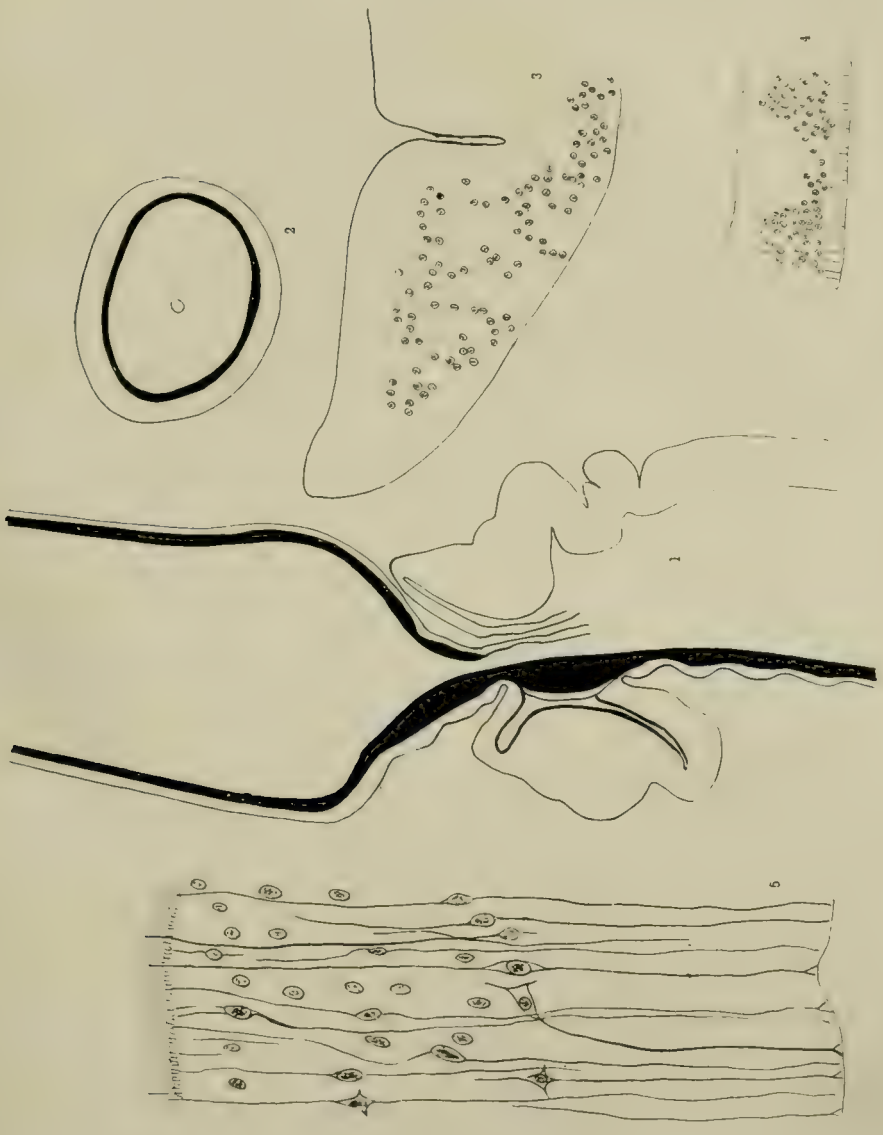
EXPLANATION OF FIGURES

Fig. 1. Longitudinal section of part of the proboscis, the collar and part of the body of *Dolichoglossus*. The dorsal side is at the left. The nervous system is shown by heavy lines. X35.

Fig. 2. Cross section of the proboscis showing the position of the nervous system as a heavy line. X35.

Figs. 3 and 4. Sections of parts of dorsal and ventral nerve trunks. The outside is down. X300.

Fig. 5. Section through epithelium and nerve strand showing epithelial and nerve cells. X450.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Notes on the Behavior of the Social Wasp Polistes

HORACE GUNTHORP
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One day last September the writer picked up a nest of the common social wasp, *Polistes,* which had been detached from its support, and placed it upon his desk. A short time later he was attracted by a scratching sound, and discovered that one of the wasps was just beginning to cut the cap from its cell preparatory to emerging. During the next few days a series of observations were made and notes taken covering the behavior of the wasps which emerged from their cells during that period. Miss Enteman* has made a careful study of the instincts of the social wasps, and while the observations recorded in the present paper are largely corroborative of her work, some interesting details are here added.

The cutting of the cap of the cell occupied some time, and extended around four-fifths of its circumference, the remaining one-fifth being gnawed and partially chewed through so that it was flexible enough to act as a hinge for the cap. After the cap was sufficiently cut away, the wasp started to slowly work itself out, pushing up the top of the cell like a trap door as progress was made. A good deal of effort was required to get the body out until the front legs were freed. Then the wasp had more purchase and progress was somewhat faster until the second pair of legs came out. After this slight effort seemed to be necessary for the completion of the operation.

For the next thirty minutes careful observations were made of the movements of this wasp in order to ascertain its first reactions. It is evident that they would be somewhat modified from what they are here recorded if the colony had contained the queen and other workers, as this specimen had the run of the entire nest, and none of its movements were effected by those of other individuals. It is equally evident that all stimuli came from within, or from contact with the nest, and not from suggestions received from other individuals or from contact with them. The following is the record made at one minute intervals, beginning with the time the specimen left its cell:

8:06. Specimen emerged from its cell.
8:07. Cleaned its front legs in its mouth and its antennæ with its front legs.
8:08. Moved around some. Rubbed its wings with its hind legs and spread them out twice.
8:09. Cleaned antennæ and front legs.
8:10. Swung abdomen back and forth, and brushed its wings. Moved around the nest rapidly and waved the antennæ, but all movements were jerky.
8:11. Explored nest, occasionally rubbing abdomen with legs.
8:12. Explored nest.
8:13. Explored nest. Movements unsteady. Cleaned antennæ and front legs.
8:14. Explored nest, in the course of which it went over the edge on to the back side, but immediately returned to the under side. Cleaned the front legs and antennæ, and then the hind legs.
8:15. Spread out the wings. Cleaned the antennæ.
8:16. Cleaned abdomen.
8:17. Crawled on top or back side of nest again and stayed there. Cleaned wings and abdomen.

*Minnie Marie Enteman, "Some Observations on the Behavior of the Social Wasps," Pop. Sci. Mo., 61: 339-351, 1902.

8:18. Explored top. Cleaned front legs and antennæ.
8:19. Stood still. Occasional movement of head, antennæ or abdomen.
8:20. Same as 8:19.
8:21. Began to explore again, becoming quite lively. Antennæ constantly waving.
8:22. Same as 8:21, but extended its travels to the under (cell) side of the nest.
8:23. Left the nest entirely and began to walk around the surface of the desk.
8:24. Started to climb a bottle that was some six inches from the nest. Antennæ still waving.
8:25. On the neck of the bottle, two inches above the surface of the desk. Cleaned front legs and antennæ.
8:26. Quiet except that it spread its wings once.
8:27. Still on neck of bottle. Moved its head and antennæ back and forth.
8:28. Slight change in position. Antennæ were still waving. Rubbed its wings, spread them, and then rubbed them again.
8:29. Rubbed its hind legs together vigorously.
8:30. Spread wings once, then rubbed them and the abdomen with the hind legs. Rubbed the hind legs together, and finally rubbed the right wings vigorously.
8:31. Moved around some, occasionally stopping to rub the right wings.
8:32. Explored the neck of the bottle.
8:33. Same as 8:32. Cleaned antennæ.
8:34. Same as 8:33.
8:35. Stood still but continued to clean antennæ and front legs.
8:36. Climbed up and explored the cork of the bottle.
8:37-8:40. Stood still on the cork, occasionally moving its jaws.

At 8:40 the nest was placed against the cork and the wasp immediately crawled onto it, but seemed restless. As the nest has a faint, but distinct, odor of honey, it was probably attracted to it through the sense of smell.

The next morning the specimen was nowhere in sight, but forty-eight hours later it fell out of a loose-leaf binder that had been lying on the desk. It seemed to be as active as when seen two days before. Some time during the second night after the appearance of the first specimen, that is, when it was some thirty hours old, a second individual emerged. This one was discovered on a pile of books two feet from the nest where it had evidently crawled soon after emerging.

As soon as the first specimen was rediscovered, that is, when it was sixty hours old, the second wasp then being thirty hours old, the two were placed on the nest, and this in turn was placed on a book. They both started on tours of observation, and every time they came in contact with each other they made sudden starts and jumps to avoid an evidently startling new object, meanwhile violently waving their antennæ and often cleaning these organs after such contact. Dr. Enteman says, "All wasps possess the instinct of fear. This * * * is readily overcome by the frequent appearance of the awe-inspiring object." This is true, because they were evidently on familiar terms with each other in half an hour, and paid very little attention to the frequent meetings which before had apparently distressed them. They wandered freely over their nest and the top surface of the book on which it was placed, but did not attempt to climb off the latter.

At 12 o'clock, four hours later, a third wasp had appeared, and none of the specimens seemed to be disturbed by the presence of the others. When the nest was first picked up, one cell containing a well formed pupa was uncapped. This specimen was then alive, but it may have been dead at the time of this observation. In either case, it had been dragged out of its cell, decapitated, and the front legs torn off. No trace of the head was found, but the body and legs were on the book about one inch from the nest. Whether this act was connected with the hunger of the wasps themselves or

with the first development of the instinct of feeding the larvæ in the nest, which Miss Enteman says begins without imitation, is not clear.

At 2 p. m. (two hours later) the colony was placed out of doors, still on the book. Two of the wasps soon left the latter, and settled near it, keeping very quiet for half an hour. The third kept climbing over and around the nest. At 2:30 one of the two wasps returned to the nest.

At 3 p. m. two of the specimens were on the ground near the porch. They made only short flights, resembling jumps with the wings assisting, this being true even when they were disturbed. The third wasp was beside the colony, chewing on the decapitated pupa, probably getting some nourishment from it in the process.

During the afternoon the nest was disturbed, and at 6 p. m. all three specimens had gone from the porch. One was found wandering aimlessly on a canna leaf near by. It did not seem to be able to fly well. The other two had disappeared entirely.

The nest was saved and several days later a fourth wasp appeared. It was a very lively specimen, and spent the first few hours actively exploring the nest. It seemed of a very nervous disposition, being more easily disturbed than any of the others had been. Every time the nest was picked up, it would start for the fingers or forceps holding it. At one time it was observed with its whole body in a cell, head downward, evidently examining the interior. After staying close to the nest for a day, it began to fly around the floor of the room, paying no more attention to its former home. Even when it was placed on or near it, it would almost immediately crawl or fly away. Its flying was erratic, and seemed to lack power, but it got along much better than any of the other three had done.

From the above observations it would appear that the movements of the wasp recorded at one minute intervals after emergence from its cell were probably reactions due to the discomfort of the drying and hardening of the tissues. At first the wasps apparently had very little, if any, home instinct. The only things to indicate that they had any were the facts that the first specimen so readily left the cork on which it was sitting and went back to its nest when the latter was held near it, and the fourth wasp stayed on or near the nest for the first twelve hours. But all the specimens observed left the nest the first night and showed no intention or disposition to return. The presence of a second wasp seemed to bring the home instinct into existence more forcibly, as the first and second wasps stayed with the nest for six or seven hours when they were returned to it together, while the fourth one repeatedly left the empty nest almost at once when it was returned to it. But this instinct was seemingly not very strong, as they soon wandered away when placed out of doors. They seemed to have no idea as to how to carry on the work of the colony, but wandered aimlessly over it. Perhaps this was due to the fact that they were too young, as Miss Enteman says the development of the nursing instinct is usually manifested "any time after the first half day of imaginal life," but was observed in some neuters as young as four hours, while in others it was delayed for two weeks.

While the above observations are admittedly too few from which to draw definite conclusions, they seem to warrant the following assumptions, the first three of which are quoted from Miss Enteman, and hence are simply corroborative of her work:

1. "All wasps possess the instinct of fear. This is especially strong the first few days after emergence, but is readily overcome by the frequent appearance of the awe-inspiring object.

2. "In a sense, the wasp remembers. This is indicated by the manner in which it accustoms itself to the sight of strange objects, and by its behavior when a change is made in its nest or surroundings.
3. "It shows considerable individual variability, both as to time and manner of its response to stimuli."
4. After emergence, the first reactions are associated simply with the discomfort of the hardening of the tissues.
5. It has marked curiosity, as shown by its repeated inspection of its nest and other familiar objects.
6. The "home instinct" seems to be slight when the wasp is alone, but becomes stronger when two or more are on the same nest.
7. The olfactory sense is closely associated with the early instincts of the wasp.

The Biology of the North American Crane-Flies

(Tipulidæ, Diptera)

V. The Genus Dicranoptycha Osten Sacken

BY CHARLES P. ALEXANDER, Ph.D. (Cornell)

GENERIC DIAGNOSIS

Larva. Form very elongate, terete; integument smooth, glassy, transparent; abdominal segments two to eight with a basal transverse band or area of microscopic chitinized points on the ventral surface; segment eight with a similar band on the dorsum. Spiracular disk surrounded by four lobes, the lateral pair more slender than the blunt ventral pair; dorsal lobe very low or lacking; spiracles small, widely separated; a triangular brown mark on the disk between the spiracles; anal gills a fleshy protuberant ring surrounding the anus. Head-capsule compact, massive, the praefrons large with a few marginal punctures; externo-lateral plates very broad. Labrum large, flattened, pale; antennæ two-segmented, the apical segment almost as long as the basal segment, narrowed to the blunt tip; mandibles with a blunt dorsal and two blunt ventral teeth; maxillæ generalized in structure; hypopharynx a rounded cushion; mentum deeply split behind but not completely divided, with three principle teeth and a small lateral tooth on either side.

Pupa. Cephalic crest low, depressed, setiferous; labrum tumid; labial lobes oval, contiguous; antennal sheaths ending opposite the base of the wing. Pronotal breathing-horns microscopic, represented only by tiny triangular tubercles; mesonotum unarmed; wing-sheaths ending opposite the middle of the third abdominal segment; leg-sheaths ending opposite the base of the fifth abdominal segment, the tarsi terminating on a level, or nearly so. Abdominal tergites and sternites each with four transverse rows of microscopic setæ; lateral spiracles on segments two to seven.

DISCUSSION OF THE GENUS

The genus *Dicranoptycha* was erected by Osten Sacken in 1860 (Proc. Acad. Nat. Sci. Phila. for 1859, p. 217). The genus includes a small group of crane-flies with a Holarctic distribution, there being about six species in North America and two, or possibly three, in Europe. As I have indicated elsewhere, *D. signaticollis* v.d.W. of Java is undoubtedly a species of *Libnotes*. Of the American species, *D. germana* O.S. is characteristic of the Canadian life-zone of northeastern America. *D. sobrina* O.S. is widely distributed in the United States and southern Canada, usually occurring in the Transitional and Upper Austral life-zones. So far as known at present it is the only species of the genus occurring on the Pacific slope. The remaining American species (*nigripes* O.S., *winnemana* Alex., *tigrina* Alex. and *minima* Alex.) are Austral in distribution, occurring in the southeastern and south central United States. A more detailed account of the distribution of the species is given in another paper by the writer which may be consulted (Proc. Acad. Nat. Sci. Phila. for 1916, pp. 496, 497). All of the known species are generally similar to one another in appearance and are separated by relatively slight differences of size, color and structure.

Nothing has ever been written concerning the immature stages of this peculiar

group of crane-flies. The species described hereinafter were reared at Lawrence, Kansas, and the general conditions under which they occur may be briefly discussed:

North Hollow, on the Campus of the University of Kansas, is a typical dry Austral woodland traversed by a small stream that is entirely dry during the months of mid-summer drought. The soil consists of a rich black humus that is soft and mellow except during the period of greatest dryness, being overlain by a varying depth of vegetable debris and leaf-mold. It is in this relatively dry soil that the larvæ of *Dicranoptycha* occur. The forest cover consists of Carolina poplar, *Populus deltoides* Marsh; black walnut, *Juglans nigra* L., white elm, *Ulmus americana* L.; Kentucky coffee-tree, *Gymnocladus dioica* (L.) Koch; honey locust, *Gleditsia triacanthos* L.; red bud, *Cercis canadensis* L.; yellow wood, *Cladrastis lutea* (Mx.f.) Koch; tree-of-heaven, *Ailanthus glandulosa* Desf., etc. The principle shrubs are the goose-berry, *Ribes gracile* Mx.; poison ivy, *Rhus Toxicodendron* L.; wahoo, *Evonymus atropurpureus* Jacq.; bladder-nut, *Staphylea trifolia* L.; coral-berry, *Symphoricarpos orbiculatus* Moench.; blackberried elder, *Sambucus canadensis* L., etc. The herbage is made up of tall grasses, composites and, in the spring, the all-dominant cleavers, *Galium*. In addition to the above, great tangles of lianas (*Smilax, Vitis, Ampelopsis,* etc.) are found.

In situations such as the above these Austral species of *Dicranoptycha* spend their entire lives. The first larvæ of *D. winnemana* were found here on March 20, 1918, by the writer and his wife. At this time they were well grown (length 16 mm.; diameter 0.9 mm.). They occurred just beneath the cover of fallen leaves and other debris in the upper layers of soil. Here they were associated with pupæ of *Tipula angustipennis* Lw., larvæ of *Sciara* (Mycetophilidæ); *Psilocephala hæmorrhoidalis* Macq. (Therevidæ), numerous beetle larvæ, centipedes, etc. By their elongate form and glabrous shiny skin they are very characteristic and easily recognized. The glassy appearance of the body suggests the shiny shells of a small coiled molluscan whose dead fragments occurred in some numbers in the same situations. These larvæ were placed in rearing and the first adults appeared in the breeding-cages on May 6, and from that time on continued to appear in large numbers. It was over a month later that the first individuals were taken in the field. The pupal duration could not be determined closer than ten days, and this may be the usual length of time required for this stage. The first larvæ of *D. minima* were found on July 2, 1918, in similar situations in North Hollow. At this time they were only about one-half grown. On July 11 much larger larvæ of this species were secured and placed in rearing, emerging as adults on July 21. The larvæ, like those of *D. winnemana*, live just beneath the layer of leaf-mold in the upper zone of black soil. They are usually quite sluggish in their motions but at other times are quite active. The larvæ are herbivores and feed on the rich organic earth in their haunts. When ready to pupate they encase themselves in earthen cells (10 mm. X 3.5 mm.), firm in texture, rather thick-walled but without silk. There is a small opening at either end. The length of the cavity is but little greater than the pupa itself. In this cavity the pupa rests and matures. As in other insects, the teneral pupæ are very pale yellow but gradually darken in color until, at emergence, they are of a dark brownish-black. When newly transformed the teneral flies rest on the ground and on the leaves of low plants nearby.

The adult flies of *D. germana* usually occur in the immediate neighborhood of running or stagnant water and may be swept from the rank vegetation in such places. The flies rest on the upper surface of the leaves of tall herbs and low shrubs. In

eastern Kansas, the flies of *D. winnemana, D. tigrina* and *D. minima* often occur together. In June, *D. winnemana* appears on the wing and is found associated with *Tipula morrisoni* Alex., *T. mingwe* Alex., etc.; in July, *D. minima* appears, together with *Tipula flavibasis* Alex., *T. unimaculata* Lw., etc.; still later in July *D. tigrina* emerges and all three species fly together during August and into September when they fly with *Tipula ultima* Alex., *T. unifasciata* Lw., etc. It is curious that no other species of Limnobiinæ occur in the thamnophytic association frequented by *Dicranoptycha*. All three species of this genus as discussed above have habits that are generally similar to one another. They are usually found resting quietly on the upper surface of the leaves but fly readily and on slight disturbance. Pairs in copulation are often found resting, the bodies directed away from one another and the wings folded over the abdomen. While thus united they fly readily, sometimes the female taking the initiative, sometimes the rather smaller male. The eggs are deposited in the soft earth in these situations.

NATURAL AFFINITIES

In the Monographs (1869) Osten Sacken included the genus *Dicranoptycha* in his tribe (section) Limnobina anomala, or, as it subsequently became known, the Rhamphidini, and still later the Antochini. A recent survey of the immature stages of several Antochine genera has shown that the tribe is merely an artificial grouping based on superficial resemblance of the adult flies. This heterogeneous assemblage includes representatives of at least three other tribes, *Dicranoptycha*, together with *Antocha, Elliptera, Rhamphidia*, etc., showing an undeniable affinity with the Limnobiini, whereas *Teucholabis, Elephantomyia*, etc., show an equally clear relationship with the Eriopterini. Moreover a close phylogenetic relationship with the lowermost subtribes of the Hexatomini (*Ularia, Epiphragmaria*, etc.), is easily apparent.

Dicranoptycha shows the closest affinities with *Antocha* and *Rhamphidia*. The larvæ of these three genera, each of which typifies a division, show the following common characters:

Abdominal segments with basal transverse creeping welts or areas of microscopic points. The massive compact head-capsule with the præfrontal sclerite large, distinct, the externo-lateral plates large, mussel-shaped and very thin. The mentum is not completely divided medially. The maxillæ are large and of primitive structure, the cardines and stipites distinct, the two distal lobes large, subequal in size, covered with hairs and bearing sensory organs. Mandibles with one or more dorsal and two or more ventral teeth in addition to the apical point.

The differences between these allied divisions are best indicated by a key.

LARVAE

1. Spiracular disk with only the two long ventral lobes remaining; spiracles lacking or vestigial; abdominal segments with both dorsal and ventral welts; strictly aquatic. *Antocharia.*

   Spiracular disk surrounded by four or five short lobes; spiracles large and functional; abdominal segments with ventral welts only (except the dorsum of segment eight); terrestrial or semiaquatic.

2. Body moderately elongated and covered with a long dark pubescence; spiracular disk squarely truncated, surrounded by five subequal stout lobes; mentum with five subequal teeth, the lateral one of either side not conspicuously reduced. *Rhamphidaria.*

Body very long and slender, glabrous; spiracular disk obliquely truncated, surrounded by four slender naked lobes; mentum with three subequal primary teeth and a much reduced lateral tooth on either side. *Dicranoptycharia.*

PUPAE

1. Pronotal breathing-horns branched; aquatic. *Antocharia.*
   Pronotal breathing-horns not branched; semiaquatic or terrestrial.
2. Pronotal breathing-horns distinct, elongate-cylindrical. *Rhamphidaria.*
   Pronotal breathing-horns apparently lacking, microscopic. *Dicranoptycharia.*

THE SUBTRIBE DICRANOPTYCHA

A Key to the Species of Dicranoptycha

LARVAE

1. Spiracular disk with the dark markings less extensive; the mark of the lateral lobes not contiguous with the spiracle or the triangular area on the disk; dorsal marking indistinct or lacking. *D. winnemana* Alex.
   Spiracular disk with the dark markings more extensive; the mark of the lateral lobes suffusing the ventral inner margin of the spiracle and usually closely approximated or nearly contiguous with the triangular area on the disk; dorsal marking black, transversely rectangular. *D. minima* Alex.

Description of the Species.

DESCRIPTION OF THE SPECIES

1916 *Dicranoptycha winnemana* Alexander; Proc. Acad. Nat. Sci. Phila., pp. 500, 501; Pl. 25, fig. 12.

Larva.—Length, 20-22 mm.

Diameter, 0.9-1.1 mm.

Coloration varying from white to almost black depending on the nature and amount of the food eaten which shows clearly through the transparent integument. The fat-bodies likewise show through and give a white color to the larva especially after death.

Form very elongate (fig. 1), body terete; integument very glabrous, transparent and glassy. Prothoracic segment a little longer than the mesothorax which, in turn, slightly exceeds the metathorax. The intermediate abdominal segments are elongated. The basal ring of sternites two to eight bears a transverse band or area of microscopic chitinized spicules, the one on the eighth segment split lengthwise by a capillary line. A similar band occurs in the same position on the dorsum of the eighth segment but the pleural region is devoid of such a band.

Spiracular disk (fig. 8) moderate in size, obliquely truncated, surrounded by four lobes, a pair of small, slender, lateral lobes and short, broader ventral lobes. The usual dorso-median lobe is lacking but its position is indicated by a gently rounded convexity. The inner face of the lateral lobe bears a narrow semi-lunate black mark with the concavity toward the spiracle, the proximal end acutely pointed. The ventral lobes bear a similar but smaller subrectangular black mark. A pale and usually indistinct dusky mark occupies the inner face of the dorsal lobe. On the disk between, and slightly below the level of, the spiracles is a large brown triangular or V-shaped mark. The spiracles are small, separated from one another by a distance equal to about 2.5 to 3 times the diameter of one; the center-piece of the spiracle is black, the

ring yellow surrounded by an outer dusky margin. Anal gills fleshy and protuberant as a blunt ring surrounding the anus (fig. 10).

Head-capsule (fig. 2) of the compact, massive type of the Limnobiini; præfrontal sclerite (fig. 3) large and distinct; the sclerite broad with the sides subparallel to about midlength, thence tapering gradually to the tip which is entire; there are two or three punctures at the margin before midlength. Interno-lateral plates narrow, a little longer than the præfrons; externo-lateral plates very broad, thin and flattened with the posterior margin very obtuse and the inner ventral portions continuous with the mental plate. Labrum (fig. 3) very broad and extensive, flattened, pale in color, the anterior margin with about two sense-organs. Mentum (fig. 4) deeply split behind but not completely divided, the anterior margin with three primary teeth that are subequal in size or the middle one a little smaller; a much reduced lateral tooth on either side. Præmentum smaller than the hypopharynx, in outline roughly oval or semicircular with the two labial palpi surrounded by hairs at the base. Hypopharynx (fig. 5) consisting of two chitinized arms that are contiguous but not fused medially, the concavity between them filled with a rounded cushion that is covered with tubercles arranged in more or less distinct oblique parallel rows. Antennæ (fig. 6) two-segmented, the basal segment cylindrical with an auditory plate on the face at beyond midlength; apical segment long and slender, in length but slightly less than the basal segment, tapering gradually to the bluntly rounded apex. Mandibles (fig. 7) simple with the teeth blunt; apical point longer than the lateral teeth; dorsal tooth single, broad, very flattened and obtusely pointed; ventral teeth two, a little smaller than the dorsal tooth. Maxillæ (fig. 2) of a generalized structure, the cardines distinct and feebly chitinized; distal lobes of the organ consisting of a subequal inner and outer lobe; the outer lobe with an abundance of long, delicate hairs and bearing a few sensory papillæ including one larger palpiform organ.

Pupa.—Lengh, 9.1-12.8 mm.

Width, d.-s., 1.6-1.8 mm.

Depth, d.-v., 1.6-1.9 mm.

Thoracic dorsum shiny light brown; in very old pupæ the color is much darker, but still retains a much brighter color than the leg and wing-sheaths; abdomen pale becoming darker in age, especially on the pleura.

Cephalic crest (fig. 13) low and depressed, inconspicuous, lying between the antennal bases which extend beyond it; there are four small setigerous lobes, the larger pair of which are posterior in position. Front between the eyes broad, subparallel. Two blunt tubercles on either side of the forehead. Eyes large, with coarse ommatidia. Labrum semicircular in outline, tumid. Labial lobes large, oval, contiguous with one another, at the tip of the labrum. Maxillary palpi moderately long and slender, nearly straight, gradually narrowed to the tip which ends opposite the knee-joint of the fore legs. Antennæ with the basal segments separated only by the cephalic crest, the sheaths ending about opposite or a little before the lateral angle of the thorax.

Pronotal breathing-horns (fig. 14) very small, almost microscopic; when viewed from the dorsal aspect appearing as tiny triangular tubercles. Mesonotum moderately convex, unarmed, the V-shaped suture distinct; a few setæ on the mesonotum, including one near the end of each scutal lobe. Wing-sheaths rather short, but narrow, ending about opposite midlength of the third abdominal segment. Leg-sheaths ending opposite

the base of the fifth abdominal segment, the tips of the tarsi ending about on a common level or those of the fore legs a trifle longer.

Abdominal segments (fig. 11) subdivided into four annuli that bear transverse bands of microscopic setæ; these bands increase in width from the basal to the apical. Spiracles on the pleural region of segments two to seven, lying opposite the third annulus and close to the ventral margin of the pleura. No spiracles are discernible on the dorsum of the eighth segment. Male cauda (fig. 11) with the ventral lobes very blunt, rounded; the dorsal lobes very small, terminating in a sharp spine that is directed dorsad and bears a weak seta near its base. Female cauda (fig. 12) with the ventral lobes a little longer than the dorsal lobes; the latter at the outer angle of the apex with a short stout spine that is directed dorsad as in the male.

Nepionotype (type larva), Lawrence, Kansas, April 2, 1918.

Neanotype (type pupa), with the type larva, May 6, 1918.

Paratypes, larvæ and pupæ, about fifty from the type locality, March 20 to May 20, 1918.

Dicranoptycha minima Alexander.

1919 *Dicranoptycha minima* Alexander; Ent. News, Vol. 30.

The larva is very similar to that of *D. winnemana* as described above, but is slightly smaller. The spiracular disk (fig. 9) has the dark markings much more extensive. The mark of the lateral lobes is contiguous with the spiracles and is also closely approximated to the large triangular brown mark on the disk. There is a large transverse rectangular mark occupying the inner face of the dorsal lobe. The marking of the ventral lobe is about as in *D. winnemana.*

Nepionotype, Lawrence, Kansas, July 11, 1918.

Neanotype, Lawrence, Kansas, July 21, 1918.

Paratypes, a few larvæ from the type-locality.

Explanation of the Figures

A—Labial Lobes; E—Eye; EL—Externo-lateral Plate; G—Anal Gills; IL—Interno-lateral Plate; Lb—Labrum; M—Maxillary Palpus; P—Pronotal Breathing-horn; Pf—Præfrons; S—Spiracle.

Fig. 1. Larva of *Dicranoptycha winnemana,* ventral aspect of body.

Fig. 2. The same, head-capsule, ventral aspect.

Fig. 3. The same, head-capsule, dorsal aspect.

Fig. 4. The same, mentum, ventral aspect.

Fig. 5. The same, hypopharynx, ventral aspect.

Fig. 6. The same, antenna.

Fig. 7. The same, mandible.

Fig. 8. Larva of *Dicranoptycha winnemana,* spiracular disk, dorso-caudal aspect.

Fig. 9. Larva of *D. minima,* spiracular disk, caudal aspect, the anal gills protruded.

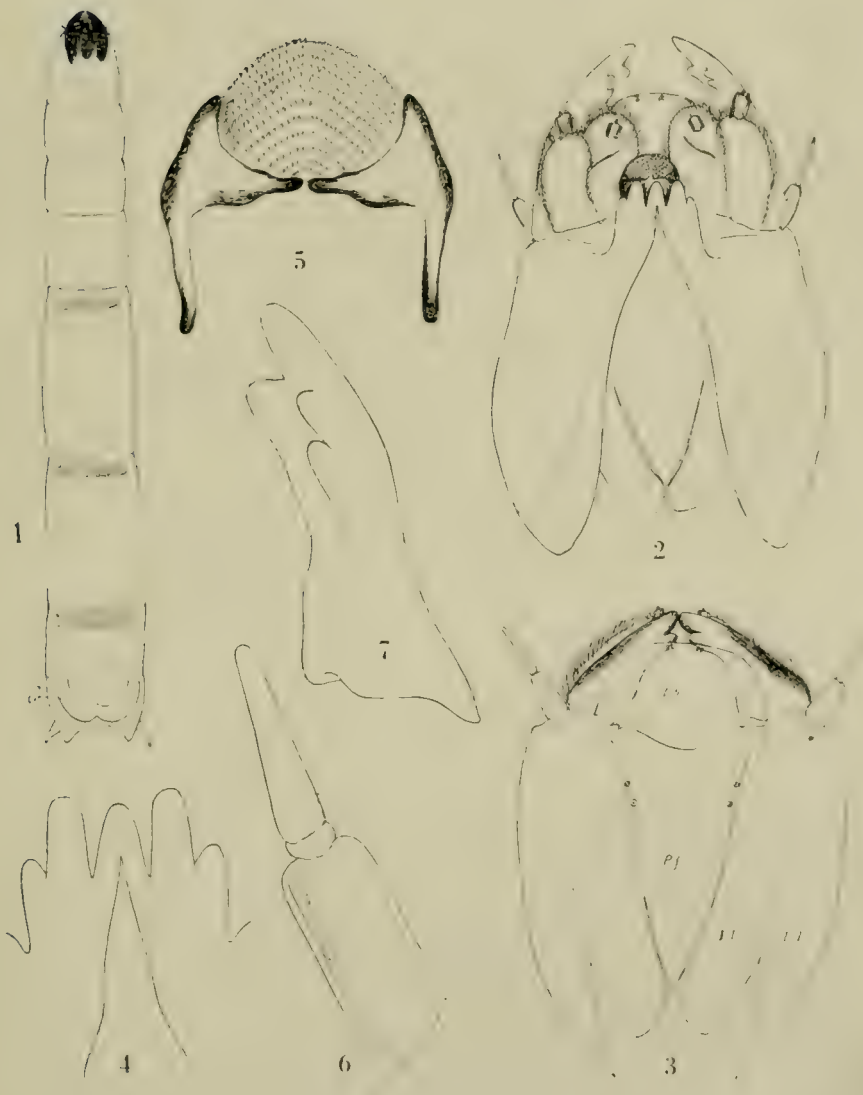
Fig. 10. Larva of *D. winnemana,* spiracular disk, lateral aspect.

Fig. 11. Pupa of *D. winnemana,* lateral aspect of male.

Fig. 12. The same, lateral aspect of female cauda.

Fig. 13. The same, head and mouth-parts, ventral aspect.

Fig. 14. The same, pronotal breathing-horn, enlarged.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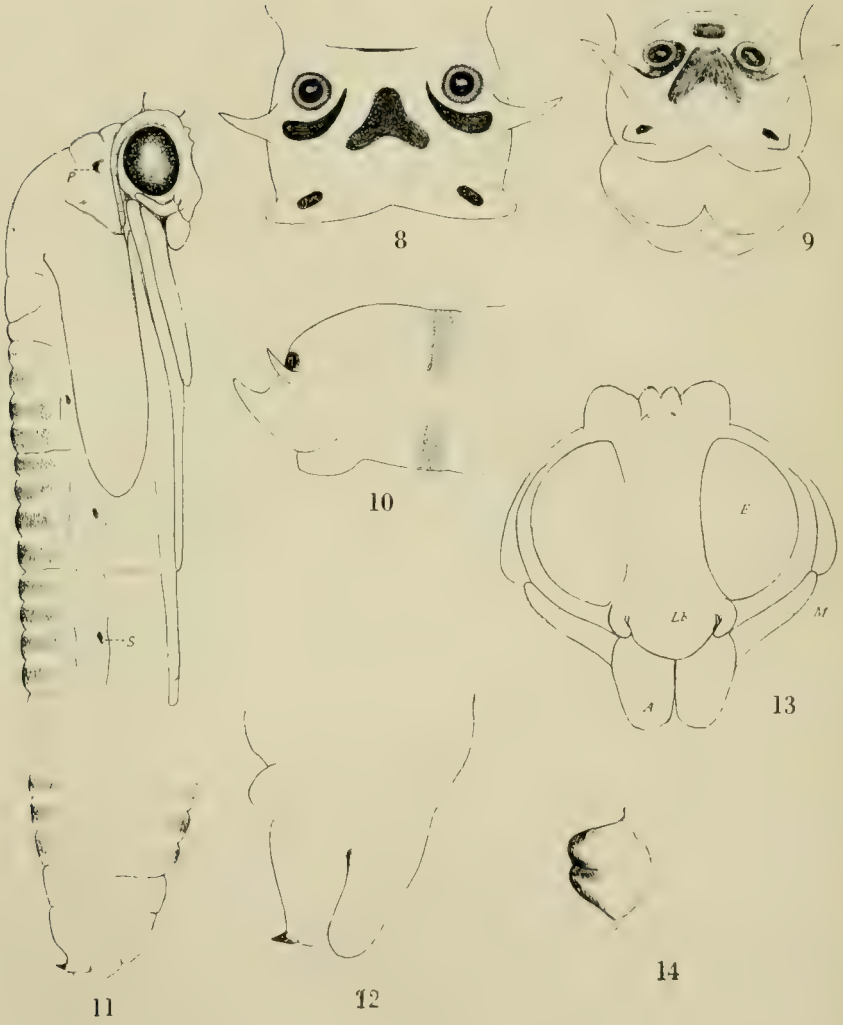
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The Central Nervous System of Nucula and Malletia

WILLIAM A. HILTON

These bivalve forms are grouped among the simplest of the molluscs. It is especially from the condition in *Nucula* as described by Pelseneer '91, that the conception of the most anterior ganglion being composed of four ganglia, has its chief support. Drew '01, who has also studied *Nucula*, believes that the lobes of the ganglion in *Nucula* are superficial and that the four connectives coming from the ganglion may be interpreted in another way. That is, that one pair of nerves may represent an otocystic branch partly fused with the connective. This view seemed reasonable to him as Stempel '99 in *Solenyma* found the otocystic nerves arose directly from the cerebral ganglion.

The two species of this group used for study were collected at Laguna Beach. *Nucula castrensis* Hinds, occurs abundantly at low tide under rocks. It is rather small for dissection, but very good complete series were obtained and stained in hematoxylin. *Malletia faba* Dall, was much less abundant. Specimens were obtained from holdfasts or from dredging. Although this was a larger species, gross dissection was not very easily carried out on any of the specimens, but good series were made.

The ganglia of *Nucula* are easily studied in section. The cerebral mass seems composed of one main mass, partly divided into four subdivisions, the two central most completely fused, and the lateral quite distinct in places. The central portion might represent the cerebral ganglia and the lateral, the pleural if we take that interpretation. The pedal ganglion is made of right and left parts quite completely fused except at the margins. The pedal mass is the smallest of the three chief ganglionic areas. The visceral ganglia are quite widely separated and a little larger than the pedal mass.

The ganglia of *Malletia* are in general plan similar to those of *Nucula*, the greatest differences being in the cerebral mass. The cerebro-pleural mass seems almost one. In most sections it is very compact and a little more complicated in structure than the ganglion of *Nucula*. However there are two small ventral ganglionic branches or small ganglia attached to the ventral side of the cerebral mass. These small ganglia may represent the visceral. Farther back in a cross section series as the cerebral mass disappears two other small branches take origin and run parallel to the nerves from the ganglionic cords. These two branches on each side seem to run together before the pedal ganglia are reached. Neither of these pairs of nerves seems connected with an otocyst.

At the cephalic end of the cerebro-pleural ganglion the large ganglionic cords are in evidence. A little distance from the cephalic end on the dorsal side there are quite large groups of cells down from the surface and surrounded by nerve fibers. The course of the fibers here is quite complex. On the ventral lateral sides of the ganglia are paired light areas of fibers which may be traced into the fibers of the ganglionic cords.

The pedal ganglion is small and much as in *Nucula*. The visceral ganglia are larger and widely separated.

In both *Nucula* and *Malletia* young specimens were used for study. In *Nucula*

there was more the appearance of four ganglia in the cerebro-pleural mass, and the ganglia seem less complex than in *Malletia*. This last species has more separate pleural ganglia, if the ganglionic cords can be so regarded.

In neither of the species studied were all parts of the connectives easy to follow, so it was impossible to test the suggestions of Drew, but in both species there is some indication of two lateral lobes of the cerebral mass, and in *Nucula* there is good evidence of two central ganglia as well as the smaller lateral ones. The lateral ganglia of the cerebral mass are most clearly separated in *Malletia*. In *Nucula* the lateral ganglia are larger in proportion and the distribution of the gray and white matter is more irregular.

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(*Contribution from the Zoological Laboratory of Pomona College*)

EXPLANATION OF FIGURES

Fig. 1. Diagram of the ganglia of *Nucula castrensis*, reconstructed from serial sections. The probable position of the connectives is shown and the proportionate distances between ganglia are given. The upper ganglion is the cerebro-pleural with large nerves leading off from the ganglion which is itself lobed into four chief lobes. The pedal ganglion is next. In section the pedal ganglion at once place seems to be made up of four parts which may correspond to four connectives from the cerebro-pleural although only one pair of connectives was clearly determined. The visceral ganglion is connected with the pedal below. X70.

Fig. 2. Cross section of cerebro-pleural ganglion. On the right side one of the lateral ganglia is shown. The one of the other side does not show because the section is not straight across. The dorsal side is up. X300.

Fig. 3. Section of the pedal mass of *Nucula*, through the center. The dorsal side is up. X300.

Fig. 4. Left side of the visceral mass of *Nucula*. Dorsal side up. X300.

Fig. 5. Nerve cells from the central nervous system of *Nucula*. X450.

Fig. 6. Section through the body of *Nucula* showing the position of the cerebro-pleural ganglion cut through the center. Dorsal side up. The cellular portion of the ganglion is black. X70.

Fig. 7. Section through the body of *Nucula* at the level of the visceral nerves which are shown on either side of the section. The area of nerve cells is shown in black. X70.

Fig. 8. Reconstruction from serial sections of the cerebro-pleural mass nerves and connectives of *Malletia faba*. The drawing is a ventral view, the cephalic side is at the top. X70.

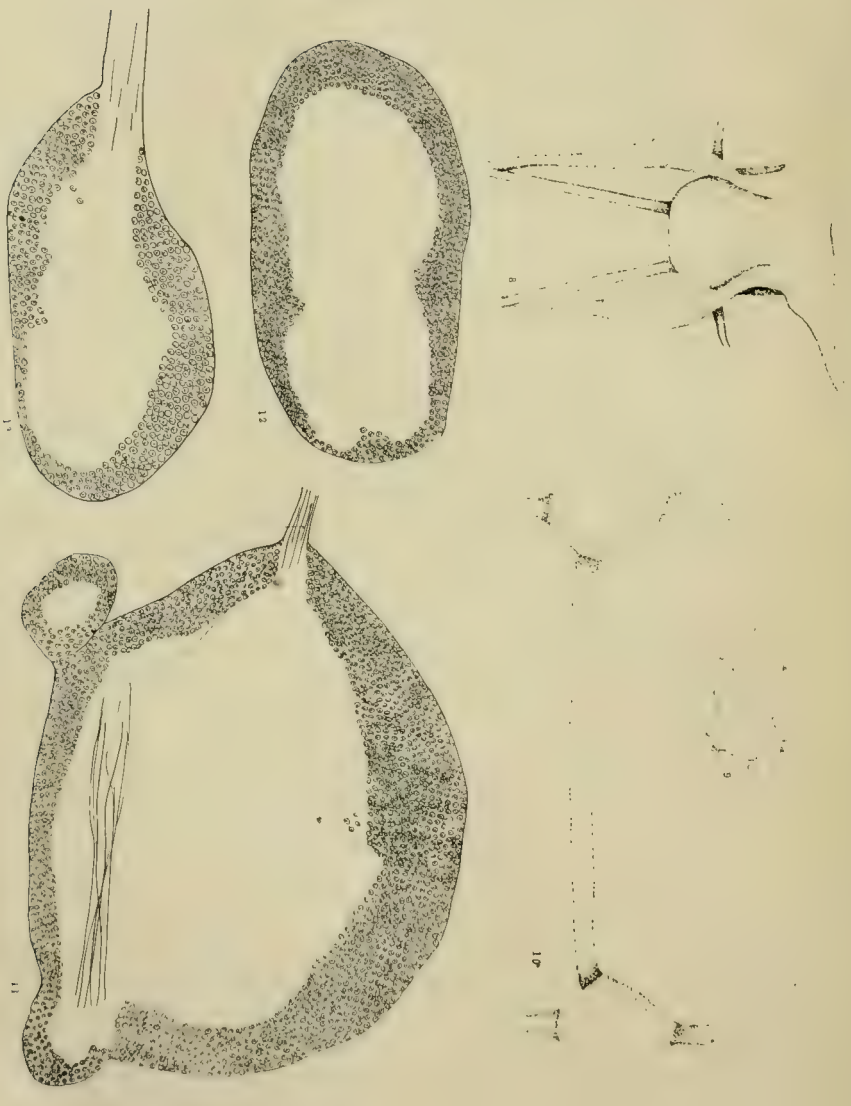
Fig. 9. Reconstruction of pedal ganglion of *Malletia* from the ventral side. Cephalic side at the top. X70.

Fig. 10. Reconstruction of visceral ganglia of *Malletia*. X70.

Fig. 11. Section through cerebro-pleural mass of *Malletia*. The dorsal side is up. On the ventral side to the left and right are the beginnings of the lateral lobes or ganglionic cords which may represent the pleural ganglia. In this species the cerebral ganglia are not separated into right and left halves as in *Nucula*. X300.

Fig. 12. Section through the central part of the pedal mass of *Malletia*. The dorsal side is up. X300.

Fig. 13. Section through one visceral ganglion of *Malletia*. The dorsal side is up. X300.



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